19. Shading Systems

19.1. Overview

This section contains general modeling guidelines that should be followed for modeling shading systems, as well as details for modeling the following:

- Louvered Blinds
- Woven Shades
- Insulating Shade Layers with Non-Standard Geometry
    - Cellular, Pleated and Roman Shades
    - Roller Shutters
    - Insulated Quilts
- Perforated Screens
- Homogeneous diffusing shades
- Awnings

19.2. Shading System Modeling in General

19.2.1. Shading System States

Many shading systems, such as venetian blinds, cellular shades, pleated shades, vertical slat blinds, and roller shades, fall into the category of a dynamic shading product that can be in both open and closed states. If you are using WINDOW and THERM to model shading systems for NFRC ratings, consult the NFRC 100 and 200 technical documents, as well as the *NFRC THERM/WINDOW Simulation Manual*, for definitions of what needs to be modeled for different shading systems.

It is suggested that for calculating U-factor, SHGC, and Visible Transmittance, different “states” of the shading system should be modeled. Different standards organizations (such as NFRC and AERC) will have definitions for what should be modeled for these states, and their documentation should be consulted for details. For example, both organizations require modeling the shading system in the “Open” and “Closed” position, with definitions for those states defined in their documentation.

Outside of those standards, the different “states” for modeling can be expanded, depending on the type of information needed. The states to be modeled might include:

- **Open** – The shading system in it’s most “transmitting” state

  The Open state could be defined in a few different ways, depending on the shading system.

  - **Retractable / Open:** Shading systems that retract up to the top of the glazing system. Even though the shading system is retracted, many times the hardware associated with the shading system will need to be modeled. There is an example of such a system in the section about Venetian blinds.
  - **Non-Retractable / Open:** Shading systems that are fixed at the bottom (do not retract up). For example, the “open” state for a non-retractable Venetian blind could be defined as having the blind slats horizontal (perpendicular) to the plane of the glass. For other systems, such as roller shades, this case may be the same as the closed state.
- **Closed** – The shading system in it’s least “transmitting” state. For example, with Venetian blinds, this would be a fully deployed blind with the slats in the vertical, “closed” position.
- **Off Angles or other states –** For a shading system with control over the shading mechanism, modeling at the different states besides Open and Closed should be considered in order to fully understand the energy impacts of each state. For example, Venetian blinds with slats that can be controlled at different angles, could be modeled with the slats at least at a 45 degree angle, and possible other angles, depending on the results desired.

19.2.2. Modeling a Glazing System with a Shading System

This section describes, in general, how to model a glazing system with a shading system. This method applies to all shade systems except Awnings, which are modeled with a window instead of a glazing system (see the Awning section for more details). By describing it once here, it will not be repeated to this level of detail in the sections that pertain to specific shading system types.

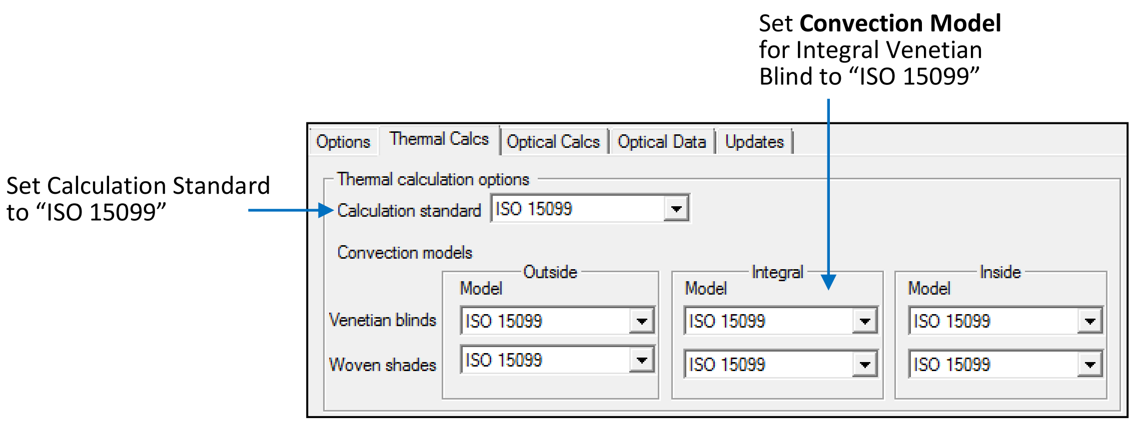
In WINDOW

Preferences

It is important to set the values correctly in the Preferences dialog box in order to produce reasonable results in WINDOW. The settings should be as follows:

Thermal Calcs Tab

- Calculation standard: **ISO 15099**



- Integral Model: **ISO 15099**

Figure 19-1. Preferences settings for Thermal Calcs Tab for Integral Venetian Blind

Optical Calcs Tab

- Use matrix method for specular systems (glazing systems without shading devices): **unchecked**
- Spectral data: **Condensed spectral data**
- Number of visible bands: **5**
- Number of IR bands: **10**
- Generate full spectrally-averaged matrix for Solar Band: **unchecked**
- Generate full spectrally-averaged matrix for Visible Band: **unchecked**
- Angular basis: **W6 quarter-size**
- Solar/Visible range: **Directional diffuse**
- FIR range: **Directional diffuse**
- # of segments: **5**

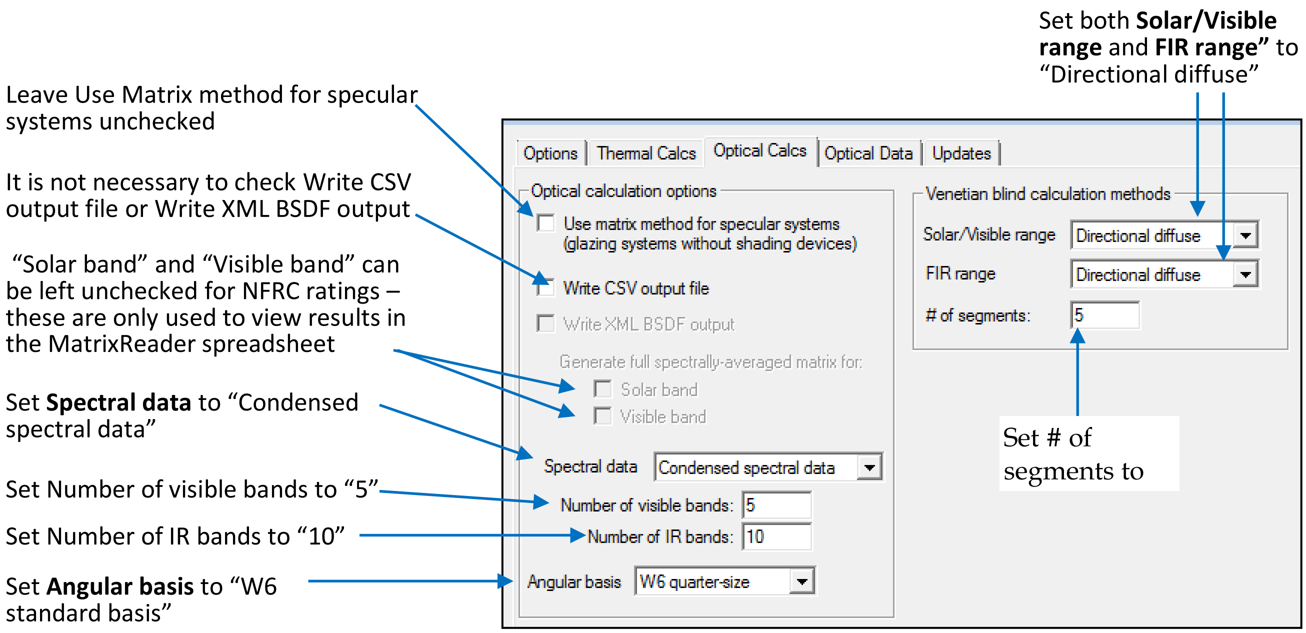
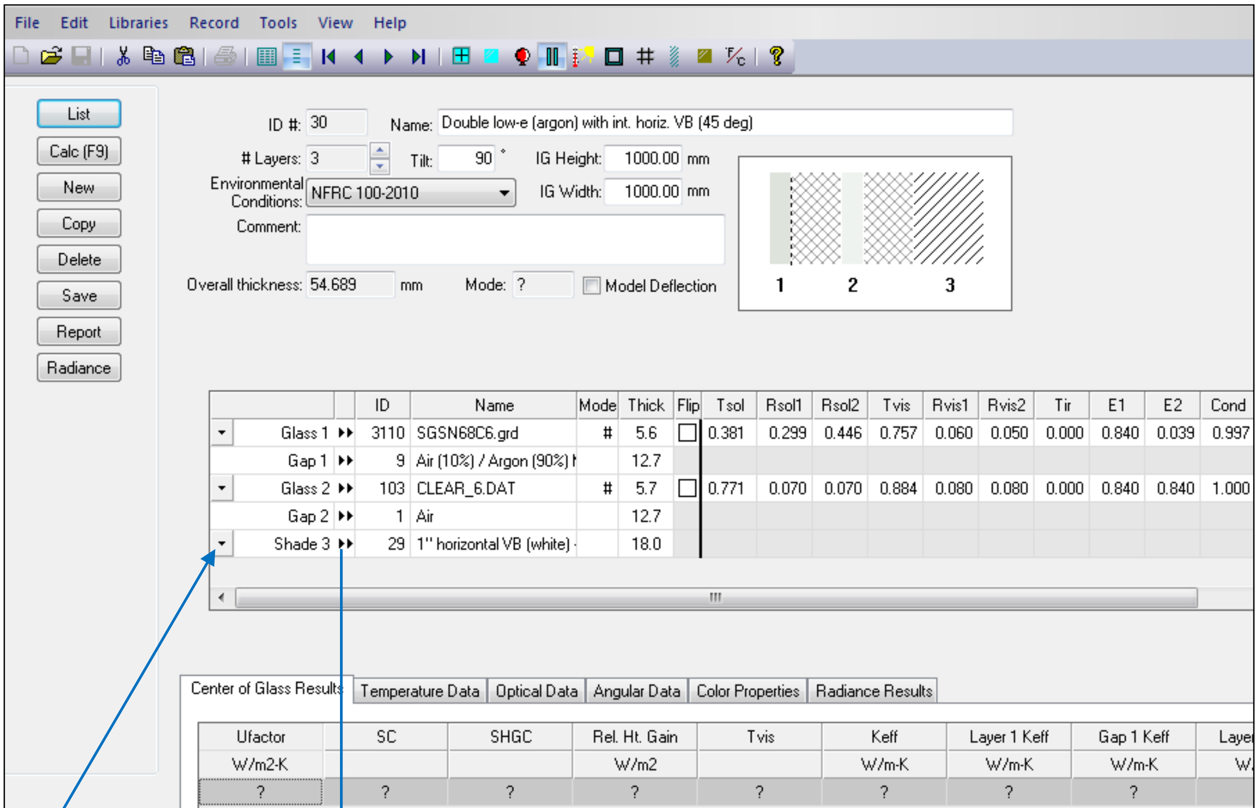


Figure 19-2. Preferences settings for Optical Calcs Tab for Integral Venetian Blind

Glazing System Library

Once the Shade Layer has been defined in the Shade Layer Library (which is decribed in detail in each shading type section), that layer can be added to a glazing system. The layer can be placed, on the inside of the glazing system, between the glass layers, or on the outside of the glazing system.

- **# layers**: Set the layers to the total number of glass + shading system layers.
- Depending on the position of the shade, set the appropriate **Layer** to “Shade” (from pulldown arrow to the left in the first column). For example, in a double glazed system:
    - If the shading layer is on the outside of the glazing system, set Layer 1 to “Shade”.
    - If the shading layer is between the glass layers of the glazing system, set Layer 2 to “Shade”.
    - If the shading layer is on the room side of the glazing system, set Layer 3 to “Shade”
- Select the appropriate shading layer from the Shading Layer library for the “Shade” layer.



Set Layer 3 to "Shade" using the pulldown for an interior shade; Set Layer 1 to "Shade" for an exterior shade, and so forth

Click on the double arrow to see the Shading Layer Library list

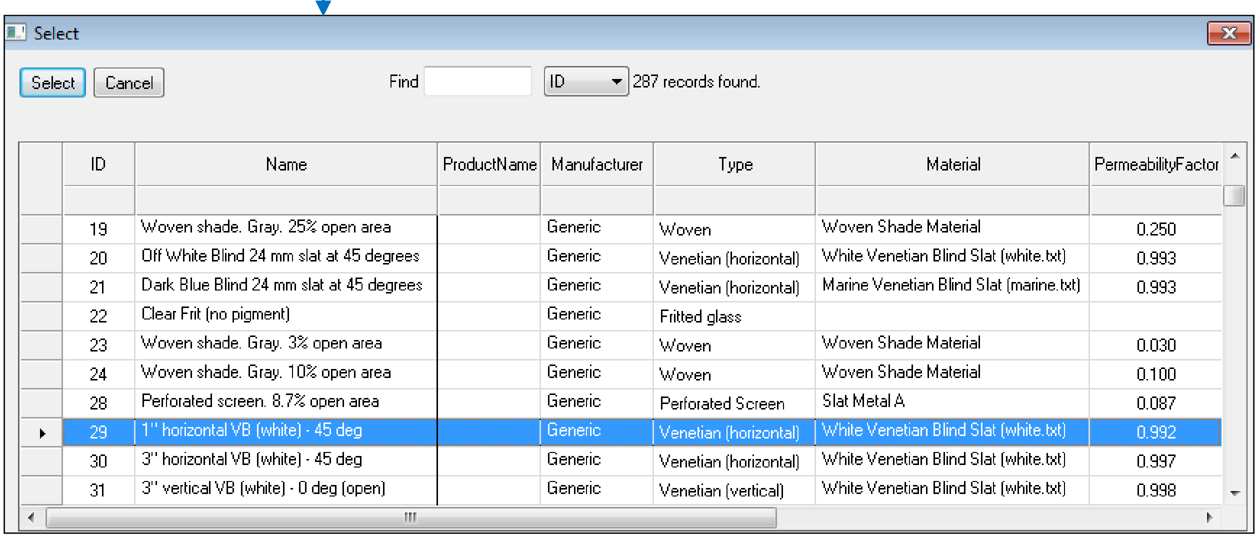


Figure 19-3.For the third layer in the Glazing System (Layer #2), select the venetian blind from the Shading System Library.

- Set **Dtop**, **Dbot**, **Dright**, **Dleft** to the appropriate values for the shading system geometry.

  In the WINDOW Glazing System Library, the values for Dtop, Dbot, Dleft and Dright represent the space between the edge of the shading system (*including hardware*) and the top (bottom, left or right) of the glazing system cavity, as shown in Figure 19-5. These values are used to define the convection that will occur between the shading system and the glazing system. These values are used for the glazing system thermal calculations in WINDOW. However they are not used to place interior and exterior shading systems in THERM, which is controlled by the "Sight line to Shade edge" input when inserting the glazing system into THERM

  It will be necessary to make a separate glazing system for each frame that has a different Dtop/Dbot/Dleft/Dright. These values from WINDOW are not used in THERM when a glazing system is imported, and therefore must be redefined when importing a glazing system. In the example below, there is no space at the top or the bottom of the Venetian blind, but there is a 3 mm space on the left and the right side of the blind.

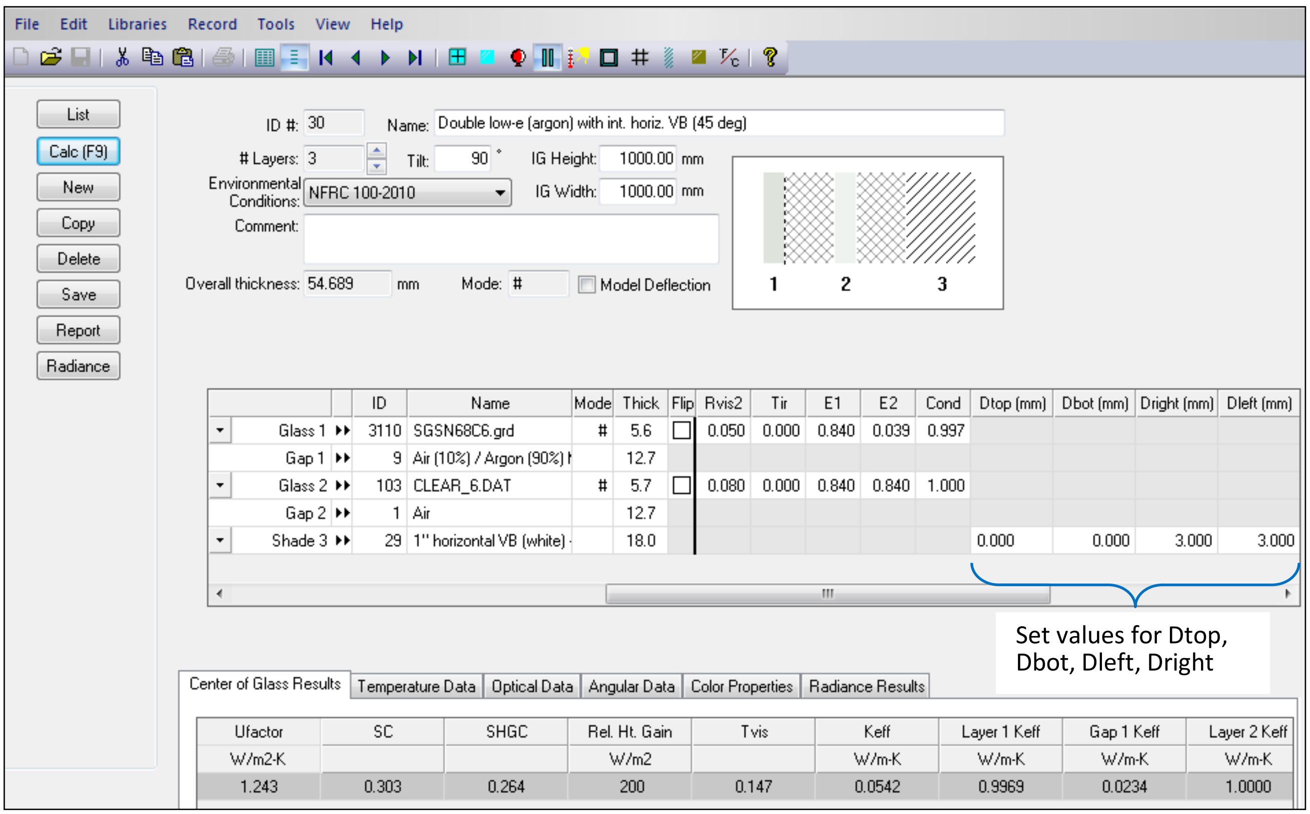


Figure 19-4. Define a Dtop, Dbot, Dleft and Dright in the Glazing System Library.

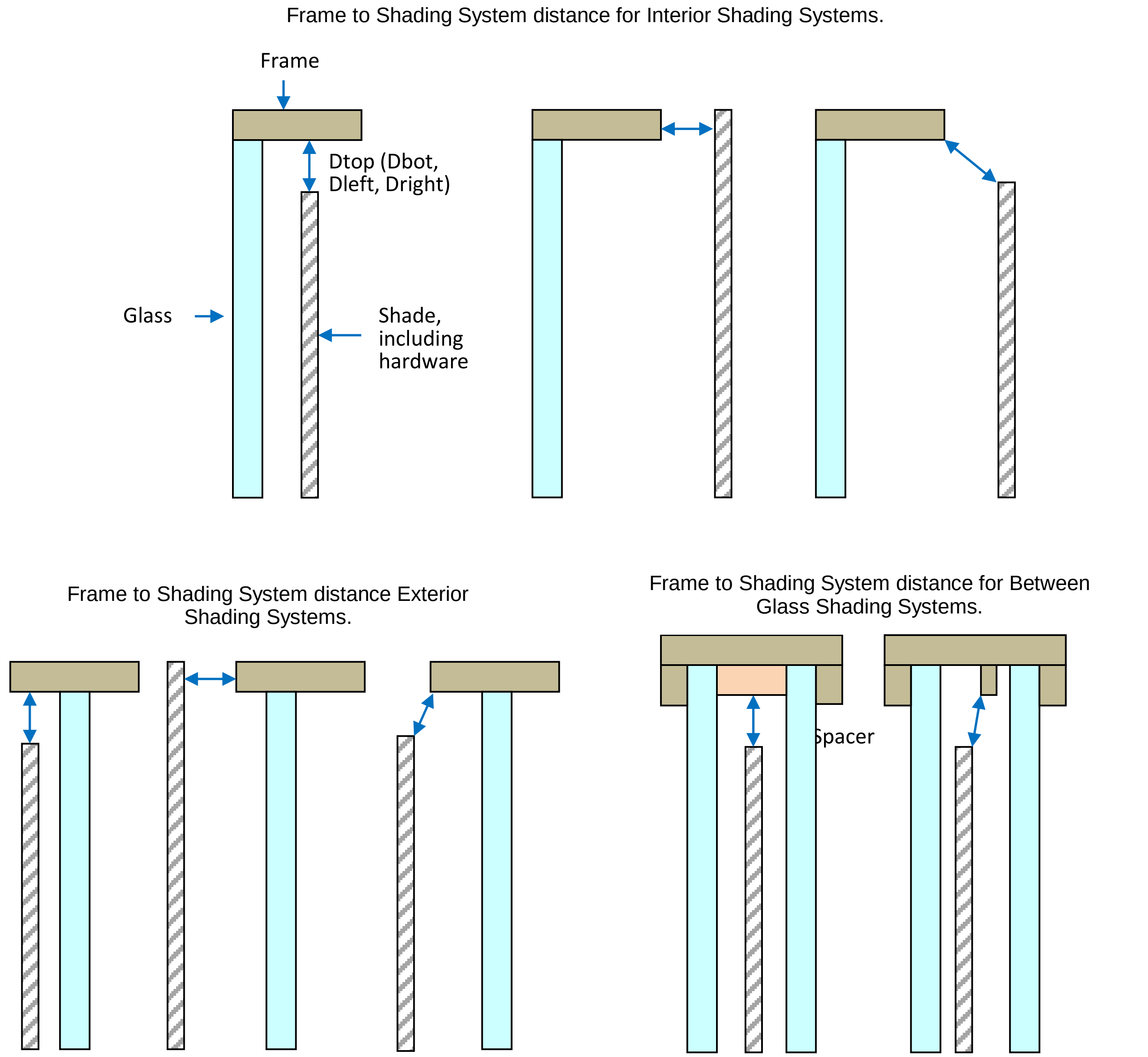


Figure 19-5. Determine the distance from the frame/spacer and the shading system at the top, bottom, left and right of the window.

In THERM

Sightline

The shading system hardware can define the sightline rather than the frame, depending on the geometry of both the frame and the shade. The sightline is used in the Tvis and SHGC calculations.

Representation of the Shading System

In THERM, the shading system is not explicitly modeled. When a WINDOW glazing system with a shading system is inserted into a THERM file, THERM draws a graphic representation of the shade, but does not create a polygon for it. The space between the shade and the glazing system or frame is not modeled as a frame cavity, and the effect on the glazing system or frame is accounted for by assigning a **Shading Modifier** when defining the boundary conditions. The **Shading Modifier** is automatically created when the glazing system is inserted, and will be available from the "Shading system modifier" pulldown menu in the Boundary Condition Type dialog box.

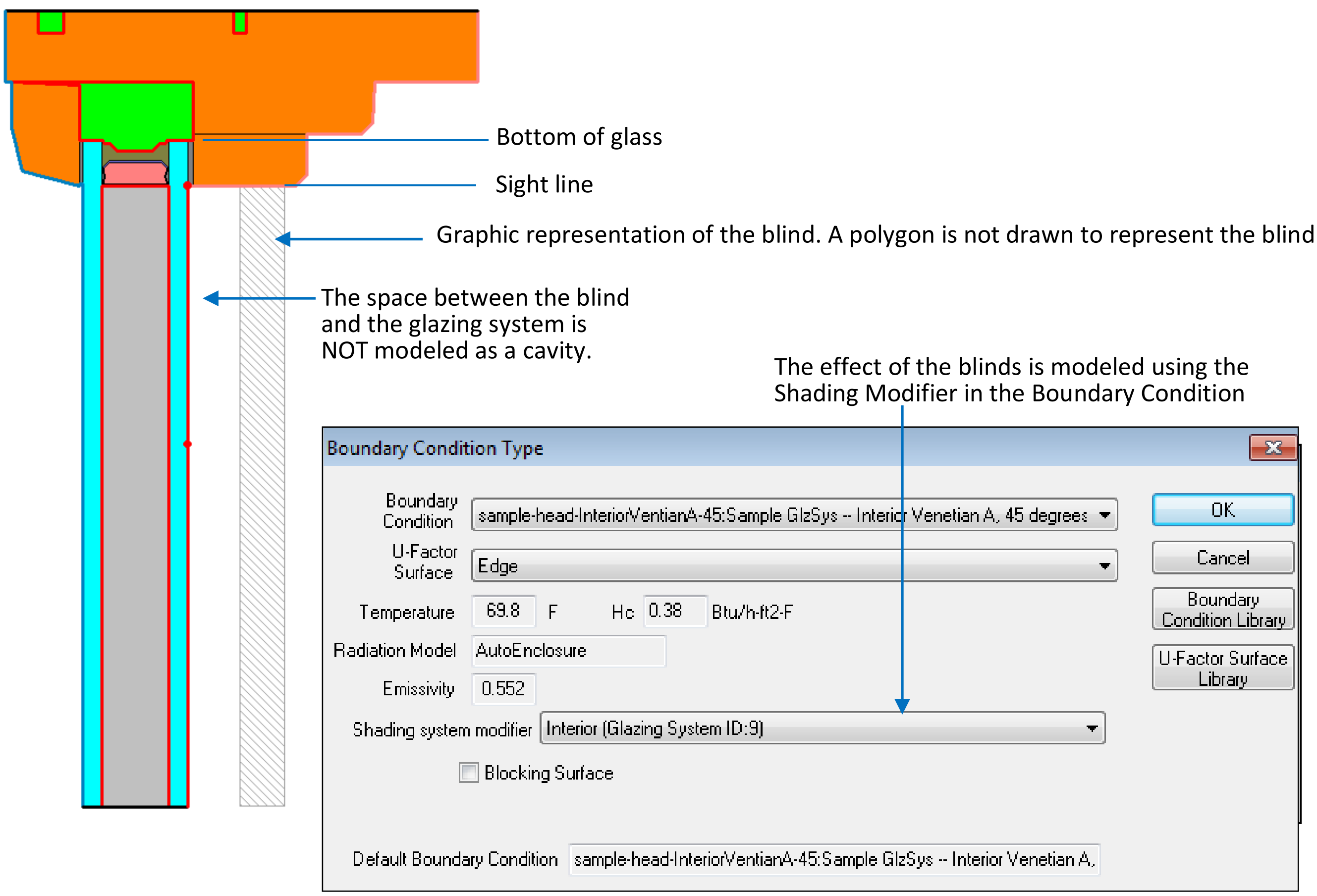
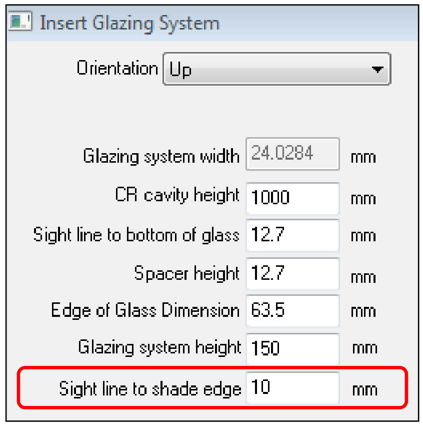


Figure 19-6. The shading system is not explicitly modeled in THERM.

Sightline to Shade Edge

When importing a WINDOW glazing system with a shading system into a THERM file, the "Sight line to shade edge" input in the Insert Glazing System dialog box will determine where the shade starts (or stops) relative to the glazing system and frame. These values should correspond to the Dtop, Dbot, Dleft and Dright input in WINDOW; however the user has to input the value for every glazing system that is inserted into the THERM file, as THERM does not read those values from WINDOW.



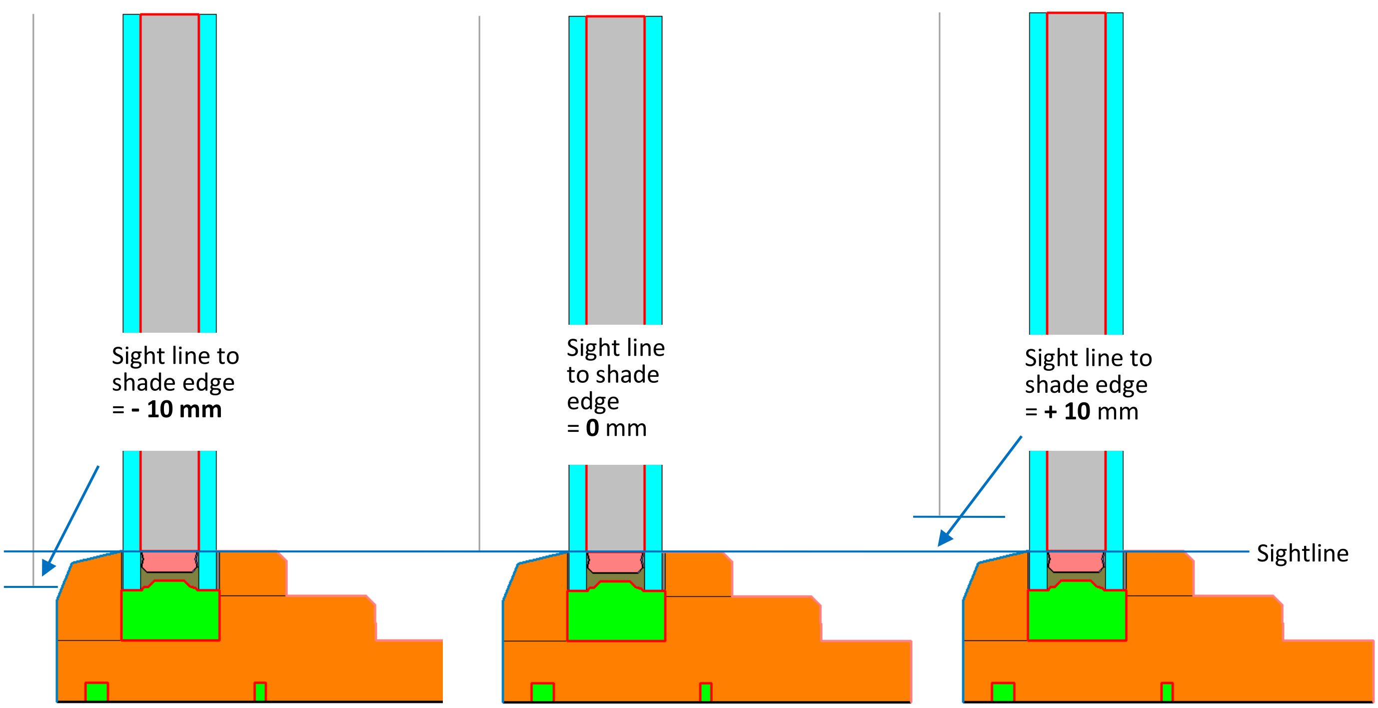


Figure 19-7. The Sight line to shade edge input determines where the shade sits relative to the frame.

For a shading system that sits in a panel next to an insulated glazing unit (IGU), where the shading system dictates the hardware, the following guidelines can be used when importing the glazing system:

- Sightline to bottom of glass = spacer height
- Sight line to shade edge = 0

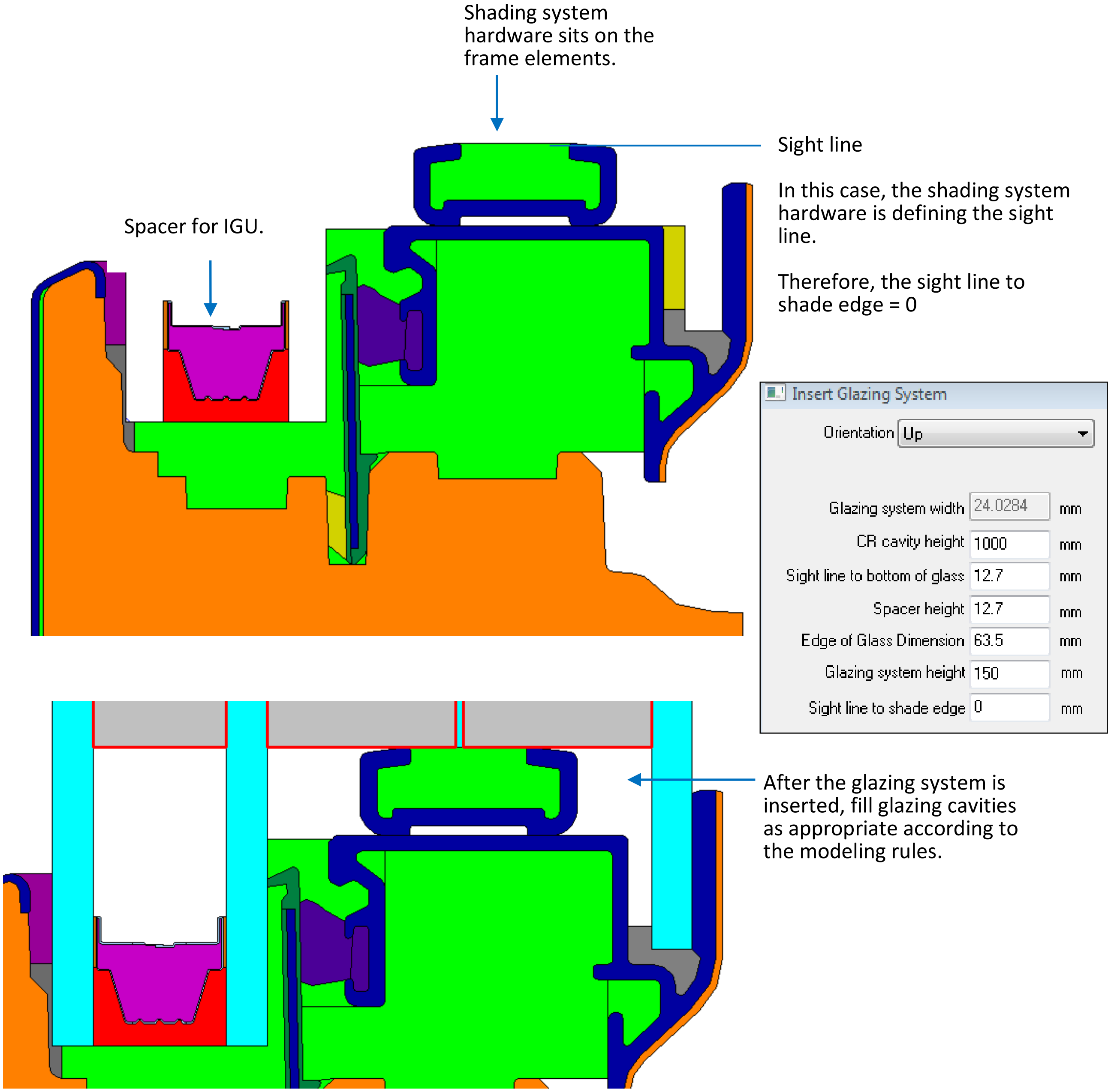


Figure 19-8. The relationship of sightline to spacer height, bottom of glass, and shade edge, for a shading system that has the hardware defining the sightline.

For a shading system where the hardware is not modeled, such as a jamb, or a head or sill that has hardware that is isolated from the frame (and is therefore not modeled), the diagram below shows how to define the input variables when importing a glazing system.

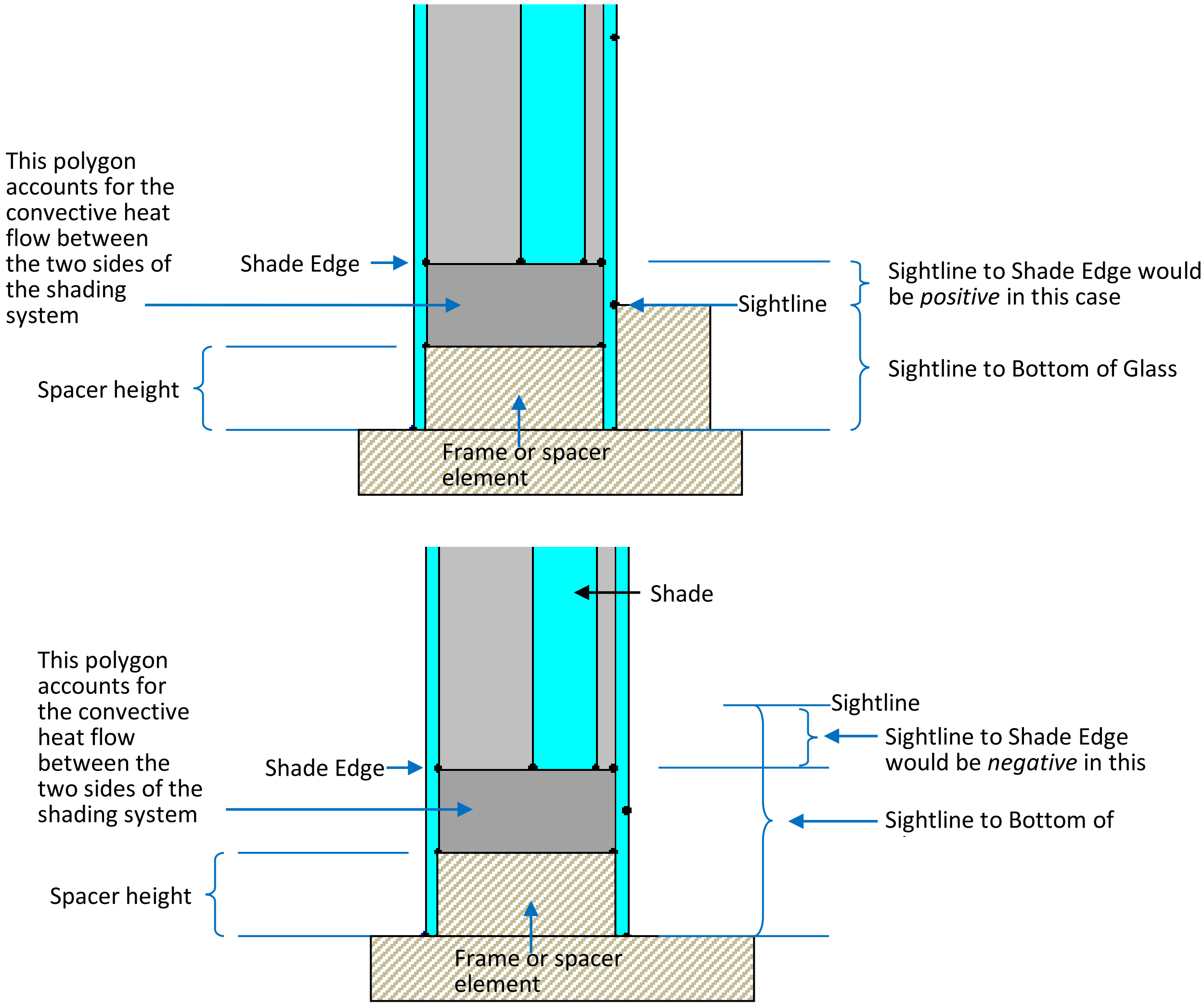


Figure 19-9. The relationship of sightline to shade edge when shading system hardware is not modeled.

Linking Glazing System Cavities to other cavities

Cavities associated with a shading system that are not modeled in the WINDOW Glazing System but which touch the WINDOW Glazing System cavities, such as cavities around hardware in the THERM file can be linked to the glazing system cavity following the 5 mm rule described in Chapter 9 of the THERM User Manual.

In the example below, the frame cavities that have a throat adjacent to the glazing cavity greater than 5 mm are linked to the glazing cavity, and those that are less than or equal to 5 mm are modeled as frame cavities.

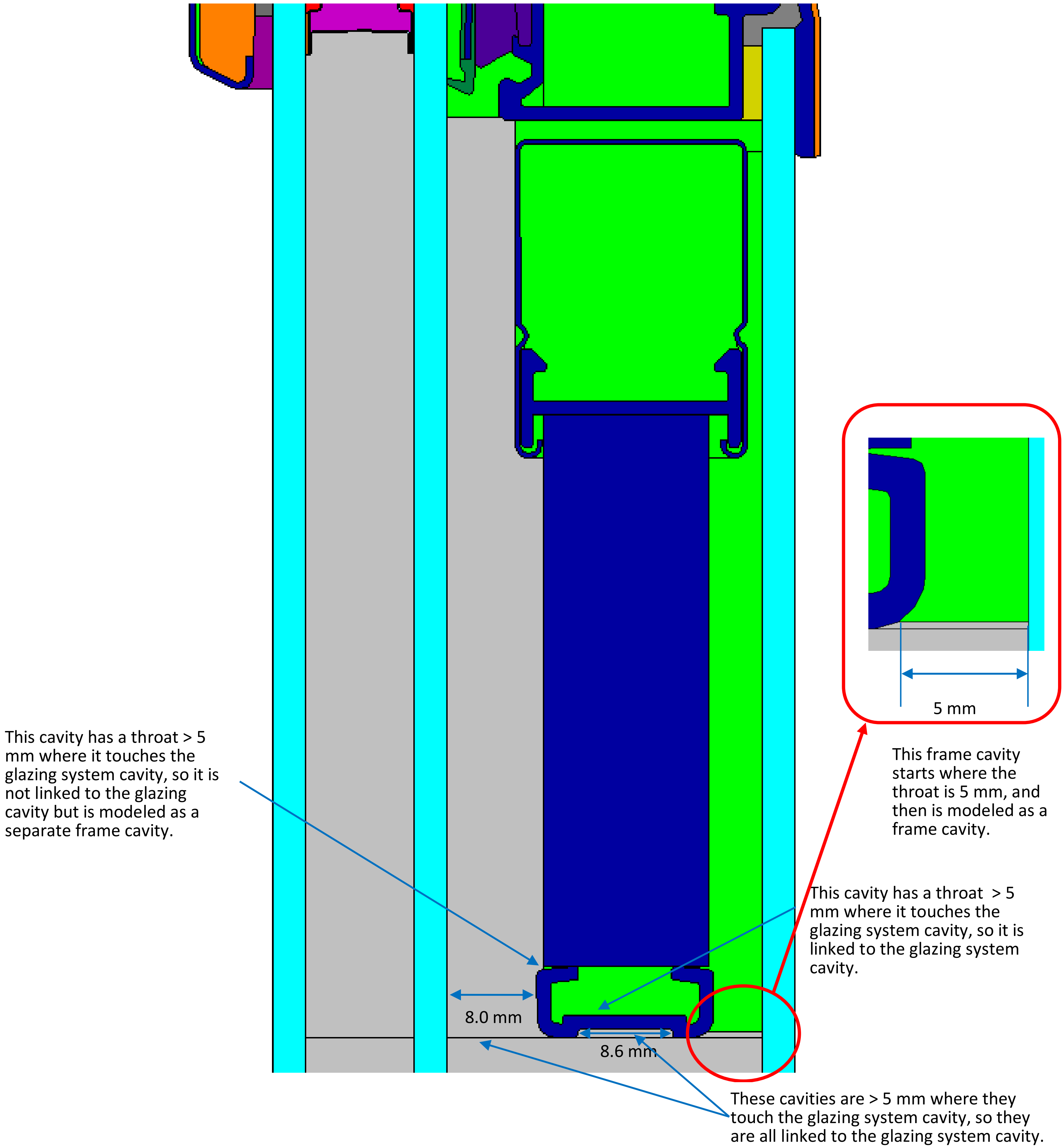


Figure 19-10. Determine which cavities around the Venetian blind can be linked to the Glazing System Cavity

Modeling Shading System Hardware

Do not model the hardware:

- If the hardware is isolated from the frame or other shading system hardware.
  For example, if the hardware that the roller in a shade is attached to is not continuously connected to the shading system housing, it does not need to be modeled, such as the roller for a roller shade which is only attached at each jamb but not continuously along the head.

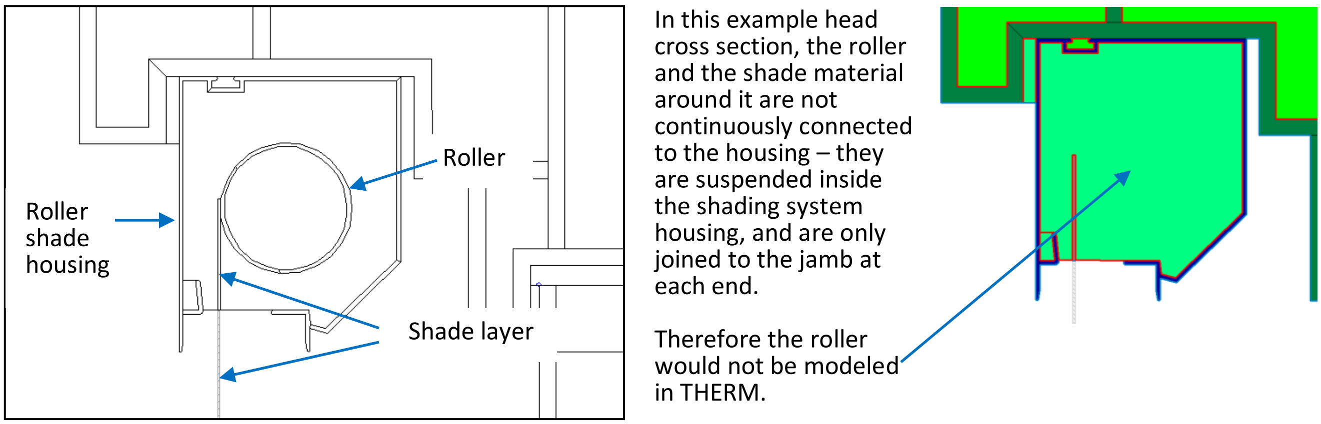


Figure 19-11. If the roller shade is not continuously connected to the shading system housing, it is not modeled in THERM

- This would also apply to hardware at the bottom of a shading system that is deployed, if that hardware does not touch the frame or other shading system hardware.

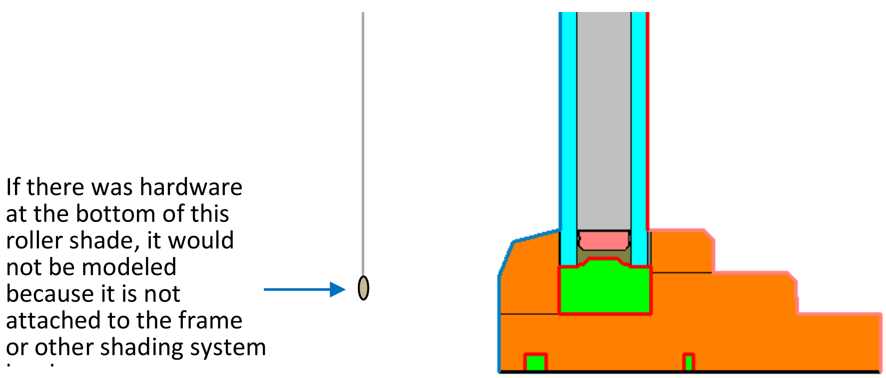
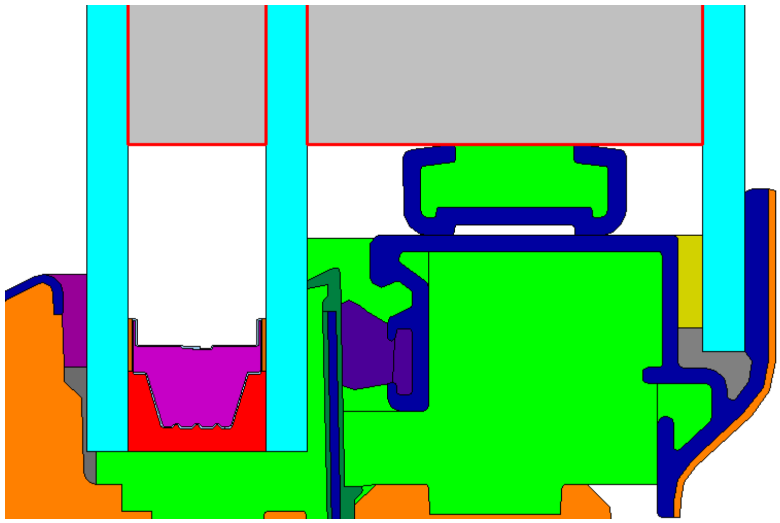


Figure 19-12. Do not model shading system hardware that is not attached to the frame or other shading system hardware.

Model the hardware:

- If the hardware is continuous and attached to the frame or other shading system hardware.
- For example, in a shading system housing, if the shade was a folded or pleated system, the hardware in the housing would be modeled if it was attached to the housing and continous.



Frame cavities inside the shading system housing:

When modeling an exterior shading system, such as a woven shade, there are three possibilities for how to model the shading system housing:

- NFRC Frame Cavity
- Slightly Ventilated Cavity
- No Cavity Modeled

The guidelines below are used to determine which model to use, depending on the housing geometry.

Shading system hardware usually has openings where the shading system intersects it. How to model these openings depends on the following rules:

- If the openness factor of the shading layer is ≤ 0.20, apply the slightly ventilated cavity rule (see Chapter 9 of the THERM User Manual) to the opening that is to the outside of the shading layer
- If the openness factor of the shading layer is > 0.20, consider the whole width of the opening to apply the slightly ventilated cavity rule.
- If the slightly ventilated rule does not apply because the opening is too small (< 2 mm):
    - model the cavity as the NFRC Frame Cavity
- If the slightly ventilated rule does not apply because the opening is too large (> 10 mm)
    - Do not model a frame cavity
    - Do not model the internal housing hardward

- Bring the boundary conditions into the inside of the shading system housing

- For the frame cavities (either the NFRC Frame Cavity or the slightly ventilated cavity) inside the shading system housing, break them up as needed according to the 5 mm rule. The cavity type stays the same even if the cavity is broken up into smaller polygons.

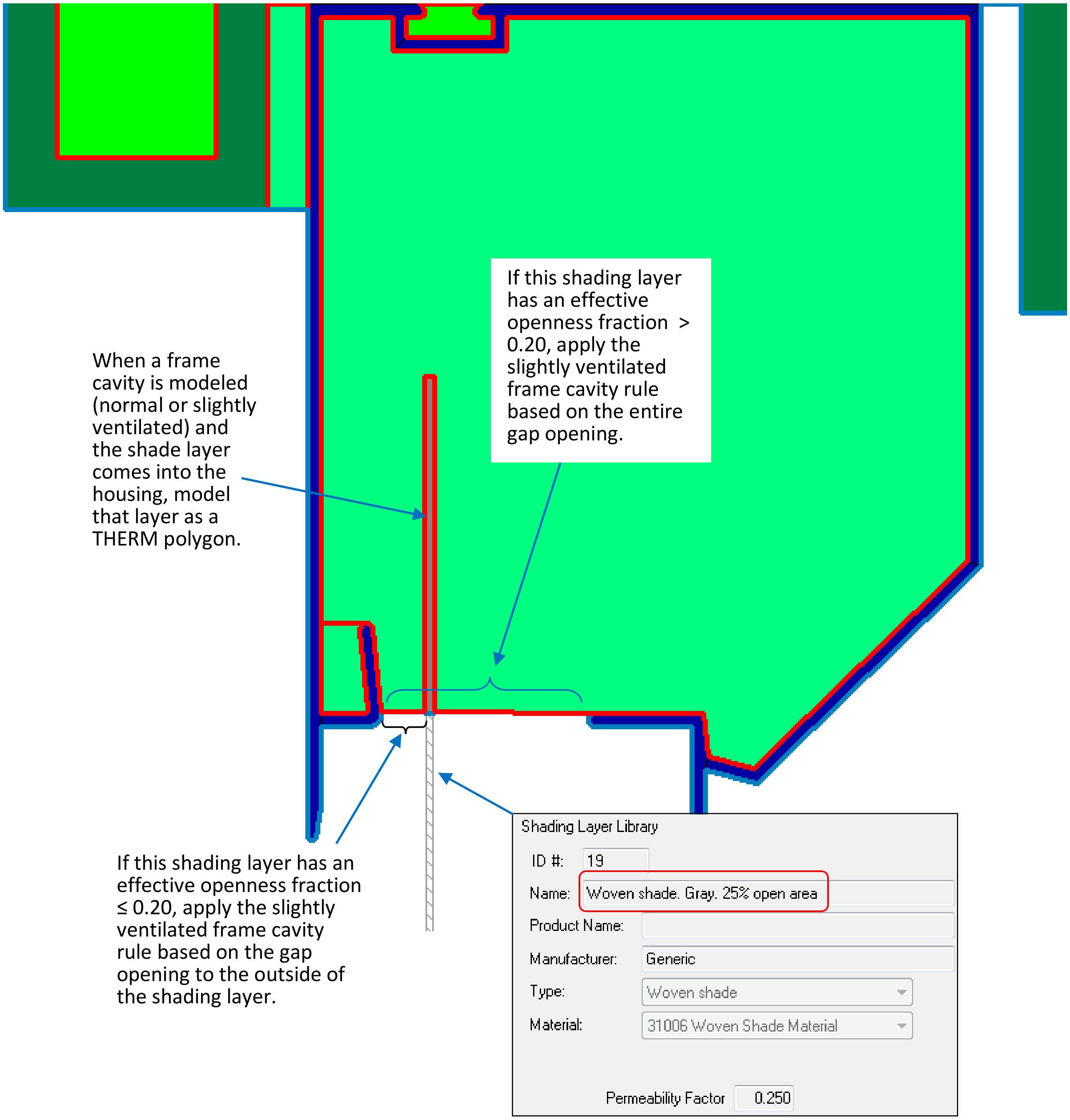


Figure 19-13. The cavity inside the shading system housing may be modeled as a partially ventilated cavity if it meets the modeling rules for that case.

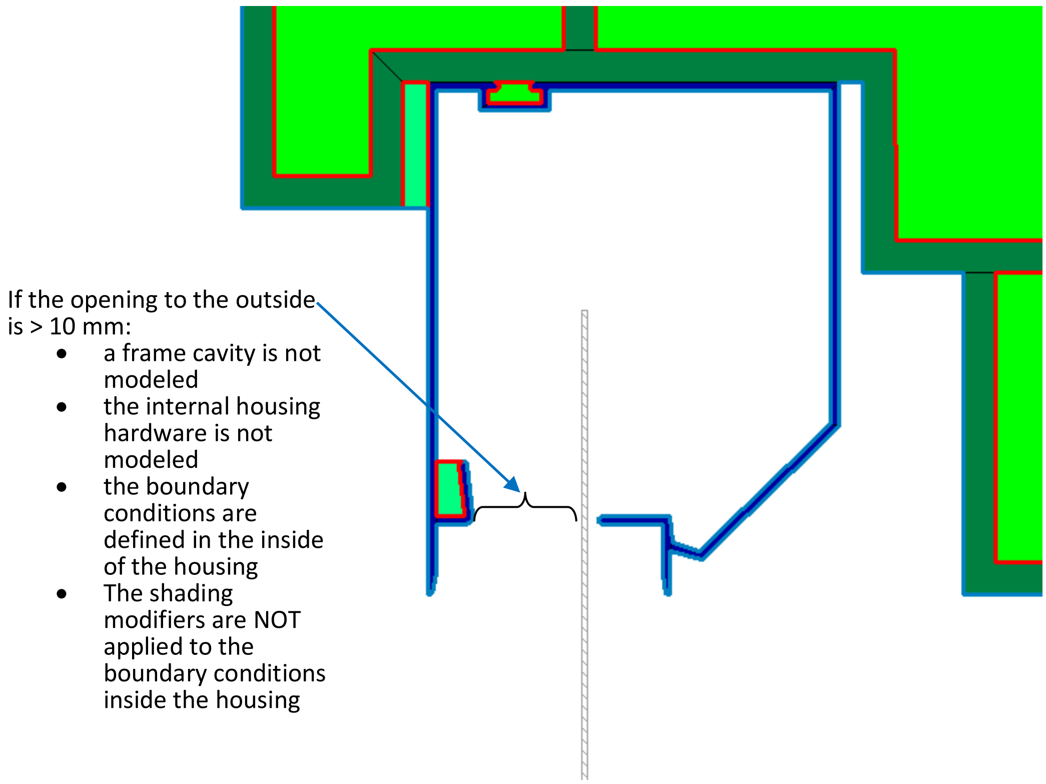


Figure 19-14. The cavity inside the shading system housing is not modeled as a frame cavity if the gap to the outside air is greater than 10 mm.

Shading layer in the shading system housing

This is independent of the Permeability Factor of the shade.

- **Bring shading layer from WINDOW into housing as built**
- **If Frame cavities are modeled, draw polygon over shade layer into housing**

  In the case where a frame cavity (either normal or slightly ventilated is modeled inside the shading system housing), if the shading layer comes into the shading system housing, for either the open or closed instances of the shading system, model that shading layer as a real polygon, and do not have the shade layer graphic element go into the housing.
- **If Frame cavities are not modeled, keep as is.**

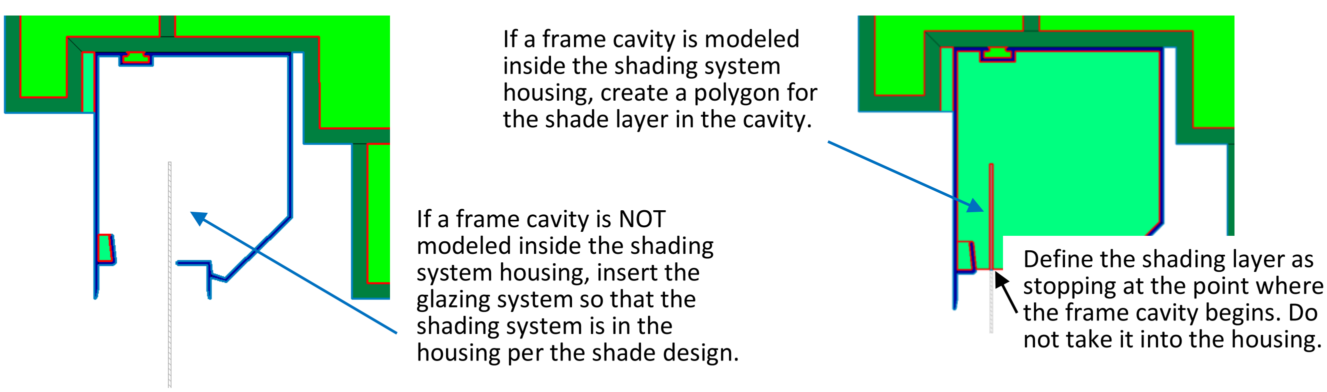


Figure 19-15. Modeling the shade layer in the shading system housing.

Shading System Modifiers

Apply the shading system modifiers, shown in the Boundary Condition Type dialog box, to all glazing and frame surfaces based on a projection of the shade onto those elements.

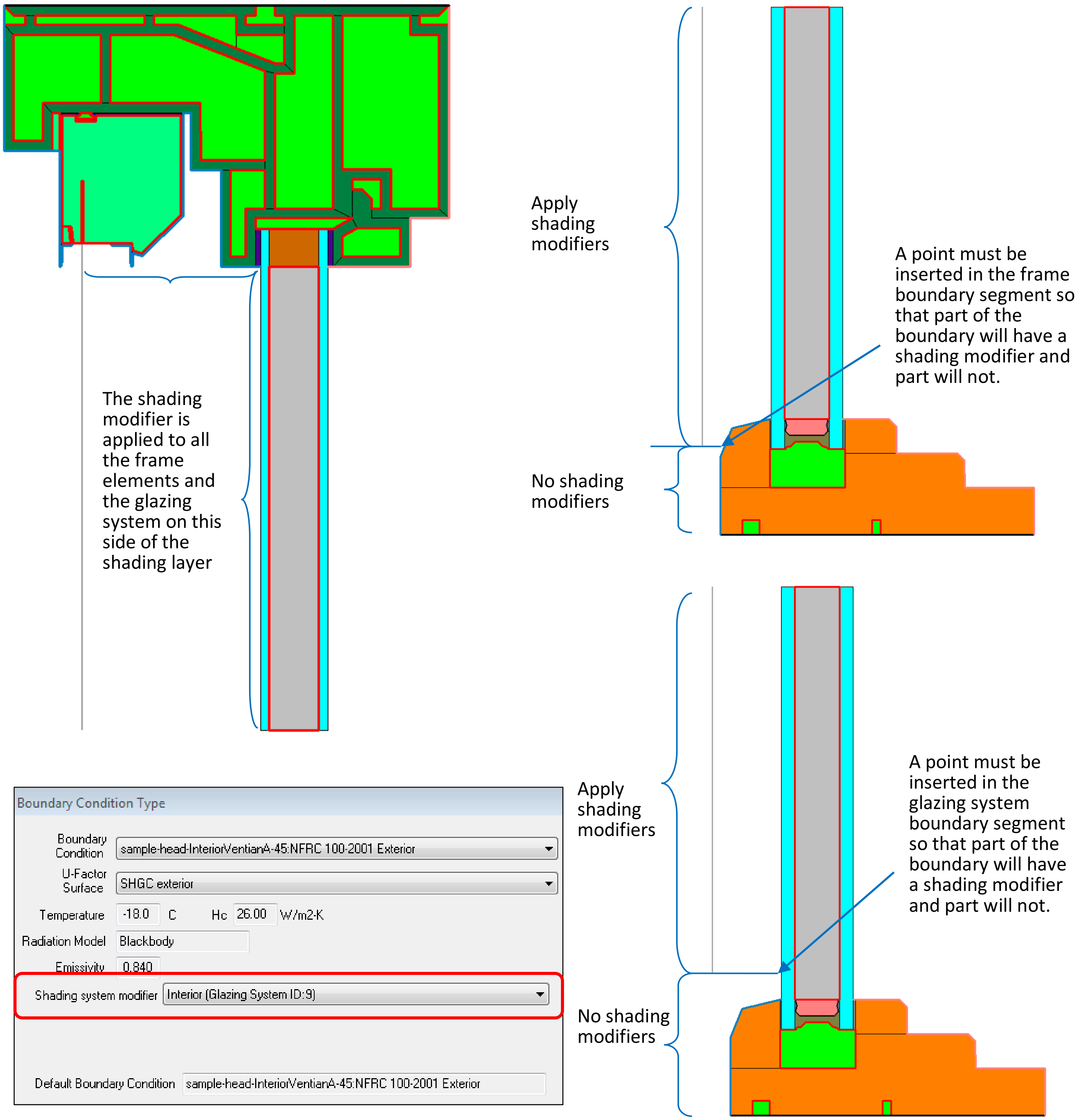


Figure 19-16. Apply shading modifiers from the Boundary Condition Type dialog box.

19.3. Louvered Blinds: Venetian Blinds – Between Glass (Integral)

This section contains a detailed description for how to model a Venetian blind between glass layers.

Venetian blinds between glass (venetian blinds between two glazing layers in a glazing system) fall into the category of a dynamic glazing product. In the example below, the blind is modeled in it's fully open and fully closed positions. In the case of modeling retractable integral venetian blinds as part of a dynamic glazing product, the fully open position is when the venetian blind is completely retracted. However, even when completely retracted, the stacked venetian blind slats become a "block" of material that must be modeled.

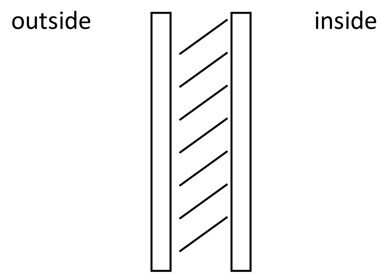


Figure 19-17. Venetian Blind Between Glass is a blind between two pieces of glass

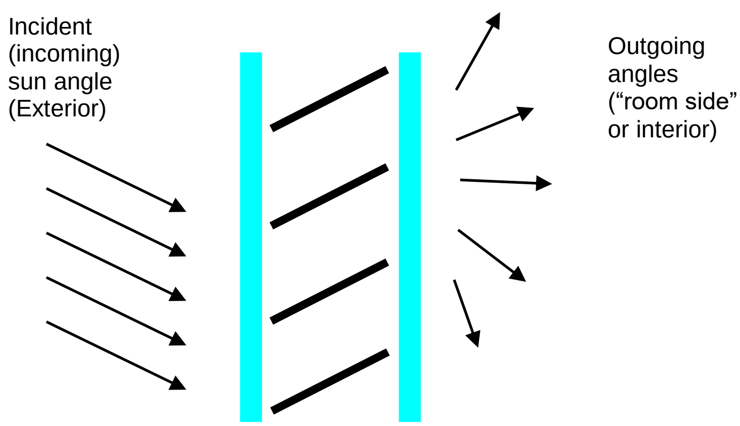


Figure 19-18.Incoming and outgoing light angles are modeled based on the angular "basis" specified.

In this example, the following "states" are modeled for each venetian blind configuration:

- **OPEN** -- Venetian blind fully retracted, ie, the most transmitting state
  - There is an example for both a retractable and a non-retractable Venetian blind
- **CLOSED** -- Venetian blind fully deployed, ie, the least transmitting state

19.3.1. Open Venetian Blind

There are two scenarios for Open venetian blinds:

- **Retractable / Open:** Venetian blinds that retract up to the top of the glazing system

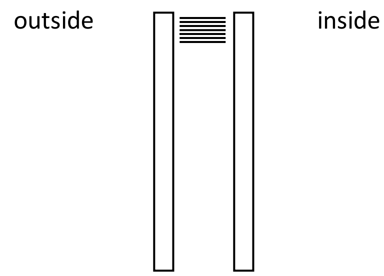


Figure 19-19. Retractable / Open Venetian Blind

- **Non-Retractable / Open:** Venetian blinds that are fixed at the bottom (do not retract up) – the "open" state is defined as having the blind slats horizontal (perpendicular) to the plane of the glass.

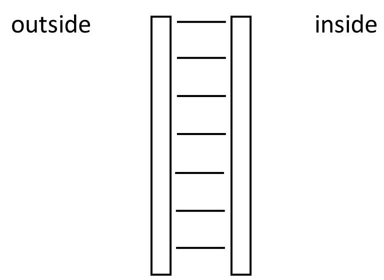


Figure 19-20. Non-Retractable / Open Venetian Blind

For **Retractable / Open**, two examples will be illustrated:

- The venetian blind fully retracted inside a double glazed system.
- The venetian blind fully retracted between an IGU and a third glazing layer (such as, but not limited to, an add-on panel).

For **Non-Retractable / Open**, one example will be illustrated:

- The venetian blind inside a double glazed system with the venetian blind slots in a horizontal (open) position.

19.3.1.1. Fully Retracted / Open Venetian Blind Inside a Double Glazed System

The following section discusses how to model a fully retracted venetian blind that has a stack of blind slats at the top of the glazing system. The following figure shows the Head cross section for a venetian blind in the fully-retracted position inside a double-glazed system.

In this example, only the Head section will be shown. For Vertical Sliding windows where the lower sash contains a venetian blind between glass, the lower sash portion of the Meeting Rail section will be modeled with the same venetian blind considerations as the Head section. The other cross sections (Jambs, Sills and Meeting Stiles) are modeled normally, without any venetian blind considerations.

In WINDOW:

1. **Glazing System Library:** Create the appropriate glazing system in the Glazing System Library. In this case, it is not necessary to model a venetian blind in that glazing system in WINDOW, because the blind is fully retracted.

In THERM

1. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
2. **Glazing System:** Import the glazing system defined in WINDOW (no venetian blind modeling needed) into the frame geometry. Make sure that the **Sight line to bottom of glass** value includes the height of the block representing the closed venetian blind, so that the Frame and Edge of Glass boundary conditions and U-factor tags are defined automatically by THERM.
3. **Boundary Conditions:** Define the Boundary Conditions in the normal manner; no venetian blind was modeled in WINDOW, so the Boundary Conditions in THERM do not need to be modified for a Shading System

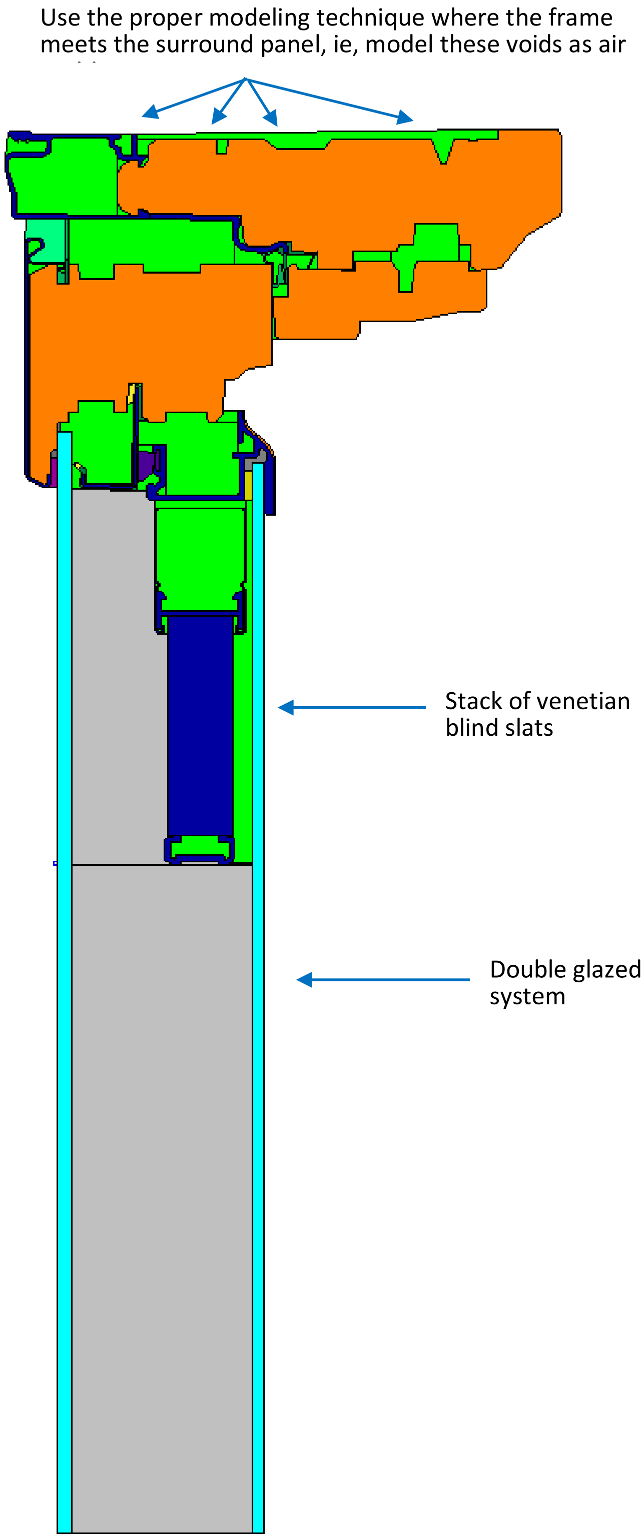


Figure 19-21. Head cross section with fully retracted venetian blind inside a double-glazed system.

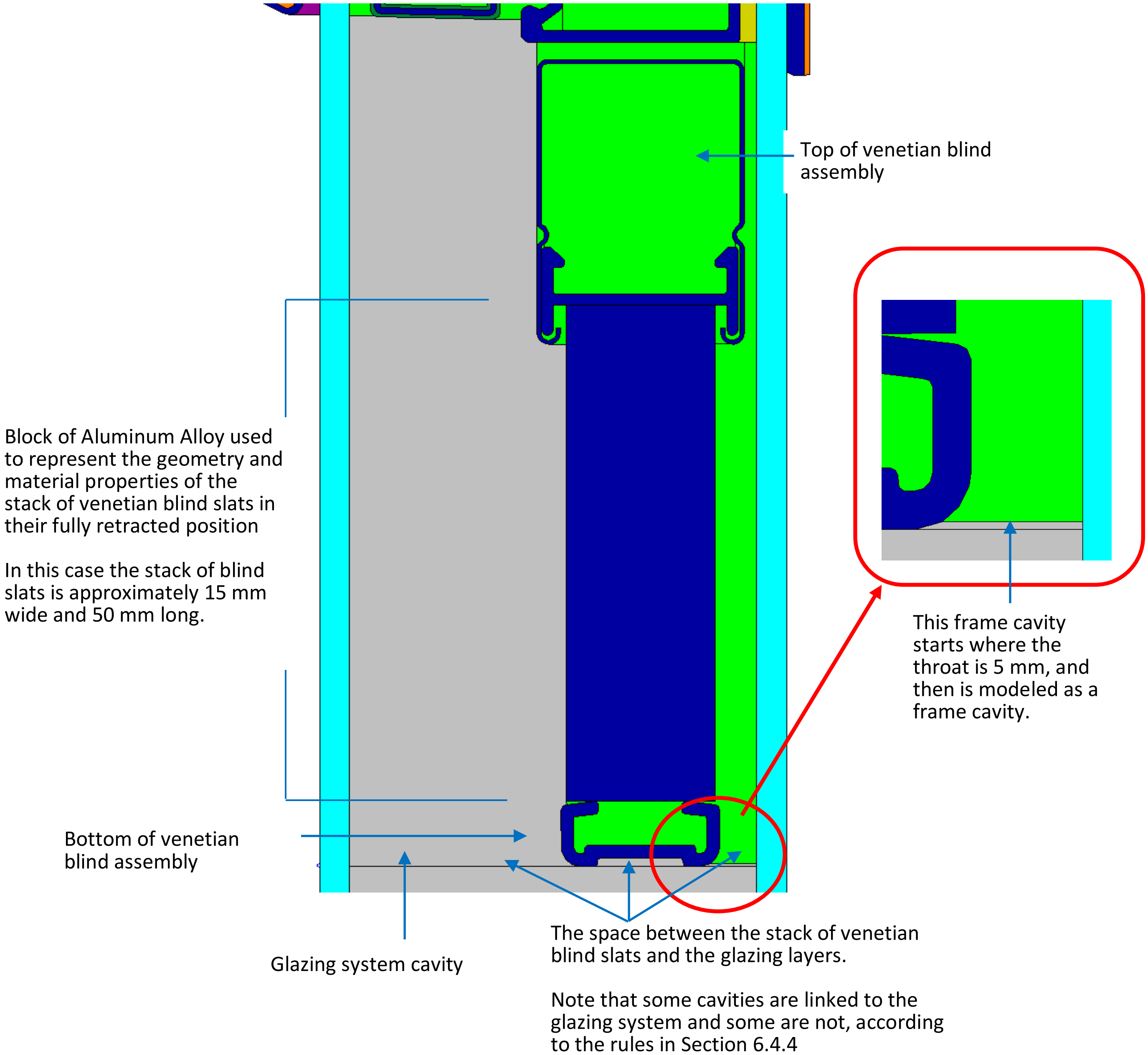


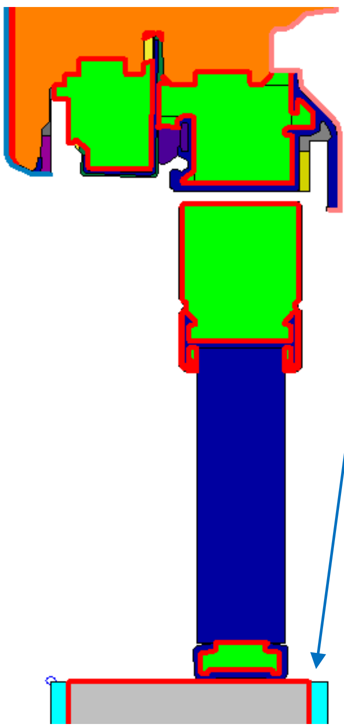
Figure 19-22. The Head cross section with the retracted venetian blind, including the stacked slats, and the top and bottom assemblies for the blind that are continuous across the section.

Follow these steps to model a fully retracted venetian blind:
(Note: This example was done for Aluminum slat blinds. If the material of the blinds is not Aluminum, use the appropriate material properties for the stack of retracted venetian blind slats; define a new material in THERM if needed.)

1. Draw the Head cross section of the product frame.
2. Draw the geometry of the retracted venetian blind, including the length and width of the stacked venetian blind slats and any continuous hardware that holds the blind in place (top and bottom). (*Note: In this case, the system seems to be "floating" because non-continuous hardware is used to attach the blind to the fenestration system.*)

3. Insert the glazing system.
   The example shown below has glazing layers that intersect the frame at two different heights. There are numerous methods for modeling this. The method shown is to "stretch" the glazing layers to meet the frame at the appropriate place, and this method also necessitates inserting points on the glazing system for the correct boundary conditions segments.

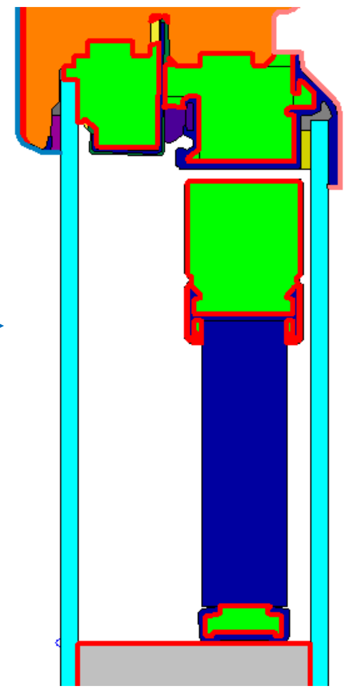
   Note: Another method would be to insert "float glass" polygons for the glazing layer extensions – this method eliminates the need to insert the points in the glazing system for the boundary condition segments.

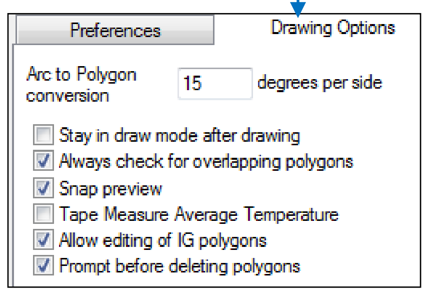


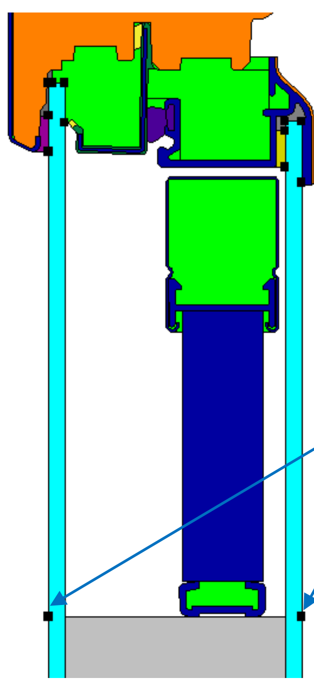
In this example the edges of the glazing system intersect the frame at different heights so the edges of the glazing system are "stretched" to meet the frame.

Insert the glazing system at the bottom of the venetian blind assembly with "Spacer height" and "Sight line to bottom of glass" set to 0.

Turn on "Allow editing of IG polygon" in **Preferences/Drawing Options**. Then pull the edges of the glazing in the glazing system up to the frame.







When inserting the glazing system, make sure the "Sight line to bottom of glass" includes the height of the entire Venetian blind assembly, so that points will be inserted in the proper places to define the boundary conditions and U-factor tags. Insert a point on the outside glass

Figure 19-23. Insert the glazing system.

4. Fill the cavities around the venetian blind with a material, and then link that material to the cavity of the main glazing system. There may be several cavities to be linked, as shown in the figure below.

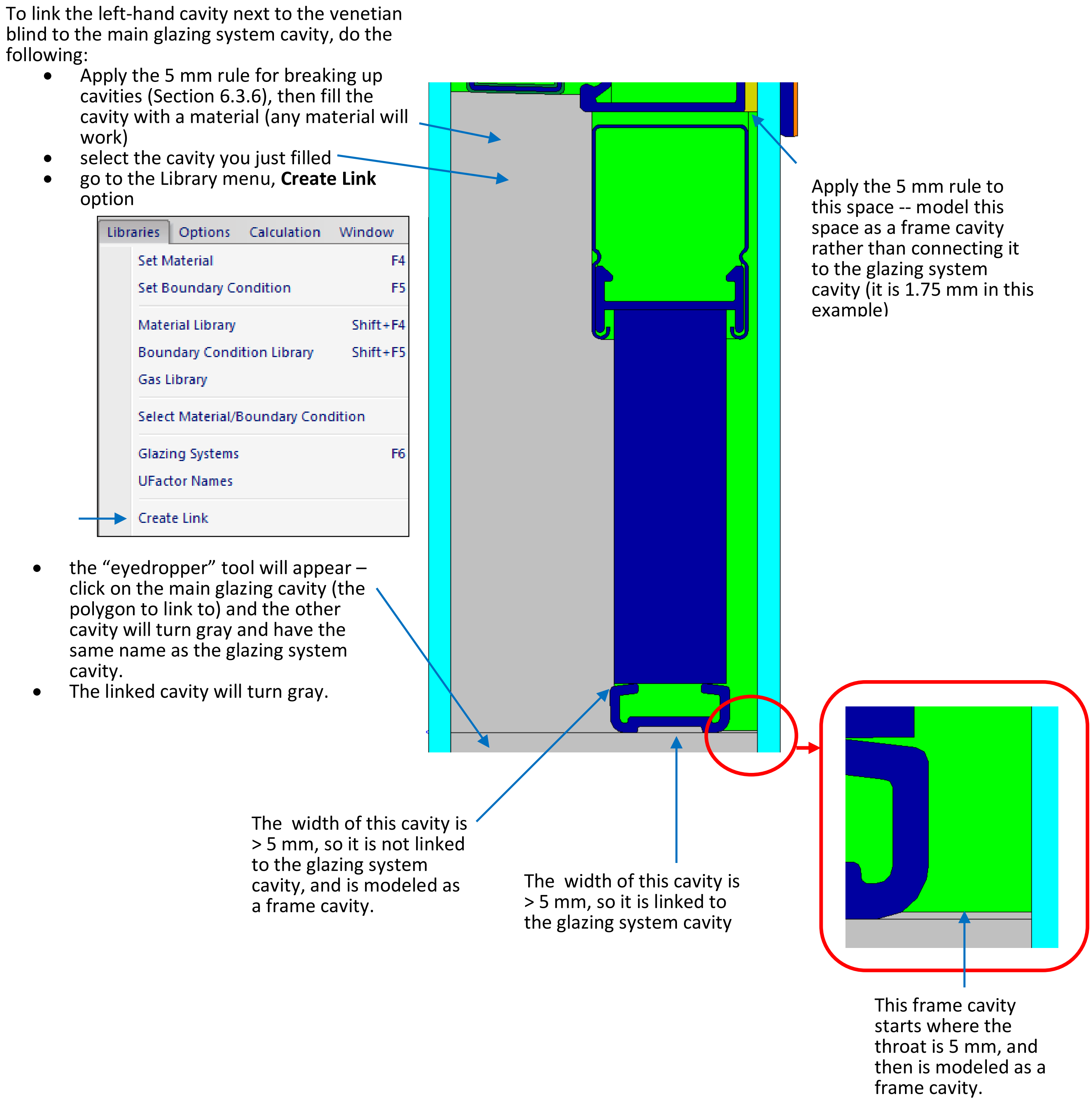


Figure 19-24. Fill the cavity next to the venetian blind by linking it to the main glazing cavity.

5.

Generate the Boundary Conditions. The section of the warm side of the glazing system adjacent to the retracted venetian blind should be defined with a U-factor Surface tag of "Frame".

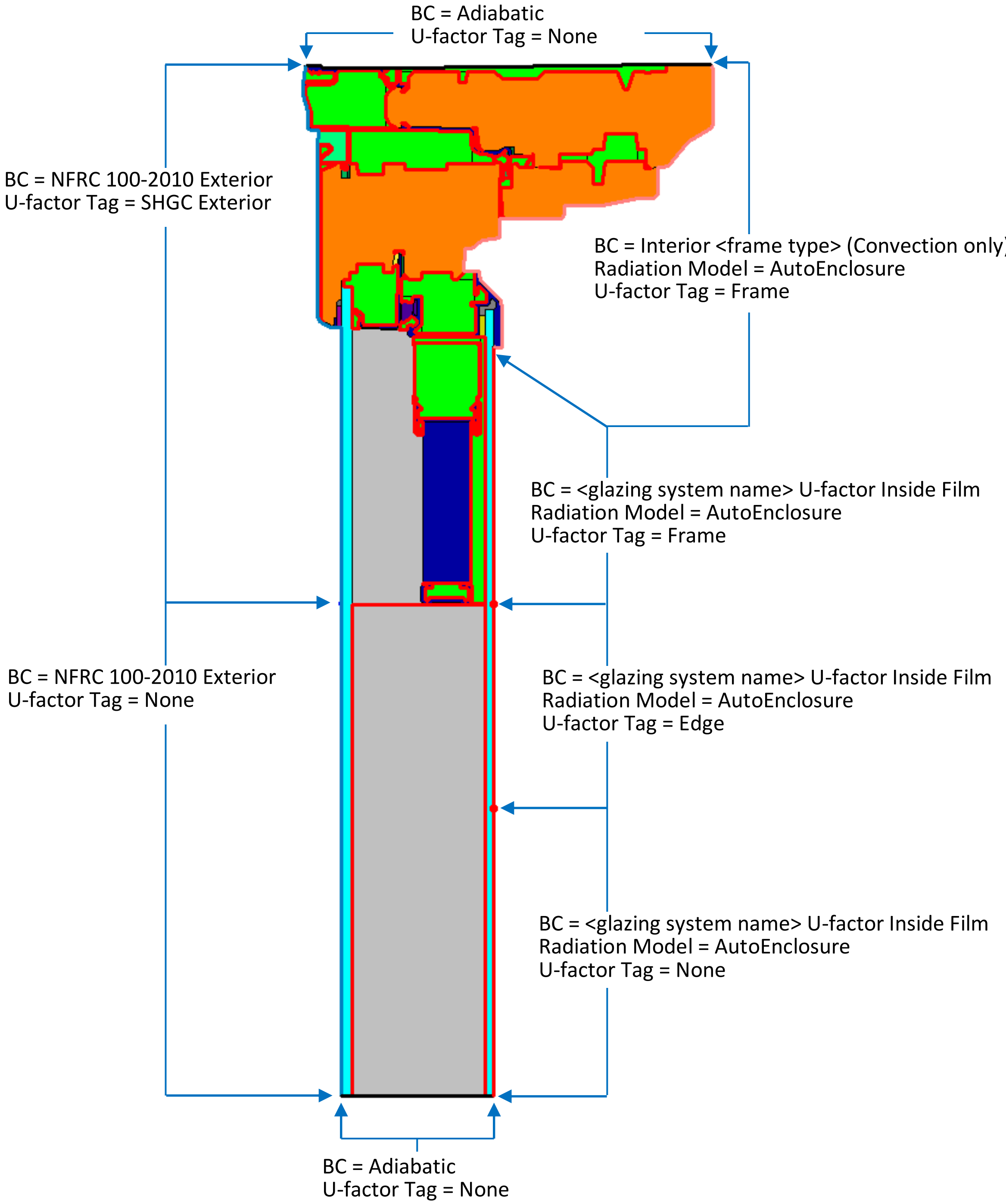


Figure 19-25. Define the boundary conditions for the cross section

6. Calculate the results for this cross section.
7. Complete the calculations for the other product cross sections (Sill, Jambs and Meeting Rails / Stiles as appropriate).
8. Import all the cross sections into the WINDOW Frame Library and calculate the total product U-value, SHGC and VT.

19.3.1.2. Fully Retracted / Open Venetian Blind Between a Double-Glazed System and a Third Glazing Layer

The following figure shows the Head cross section for a venetian blind in the fully-retracted position between a double-glazed system with a third glazing layer, such as, but not limited to, an add-on panel.

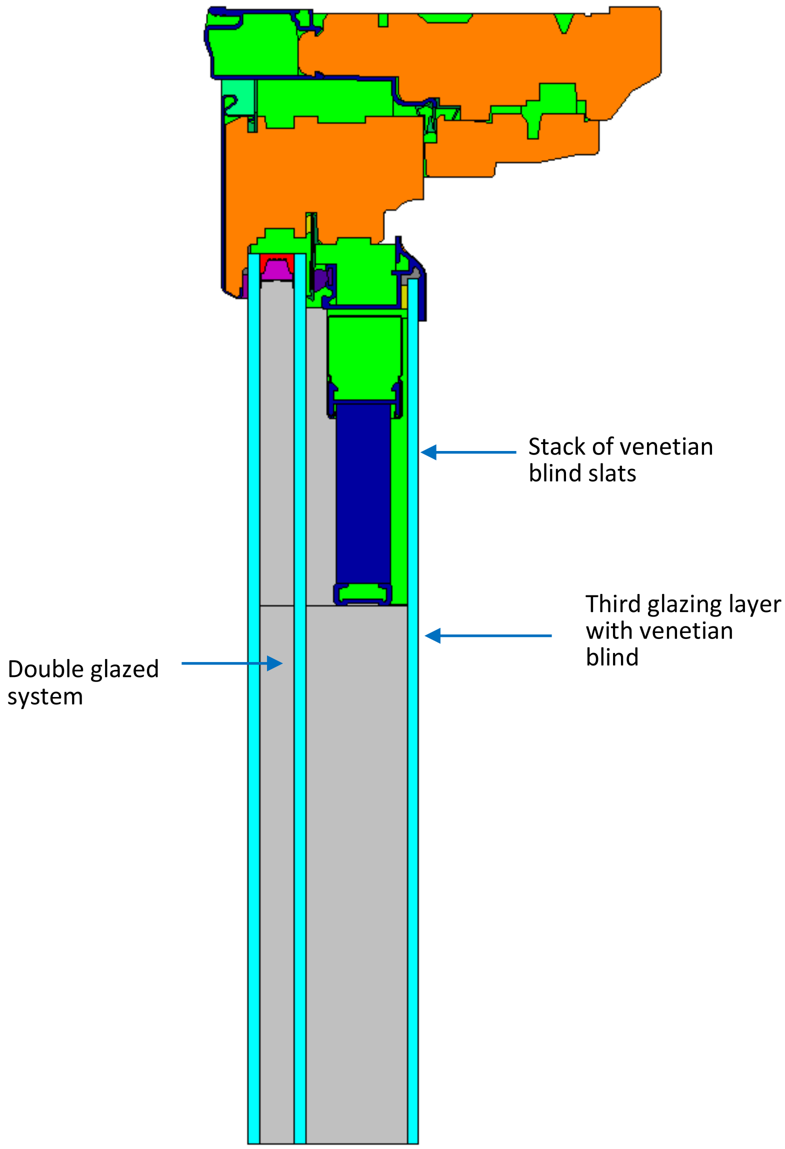


Figure 19-26. Head cross section with fully retracted venetian blind between a double-glazed system and a third glazing layer.

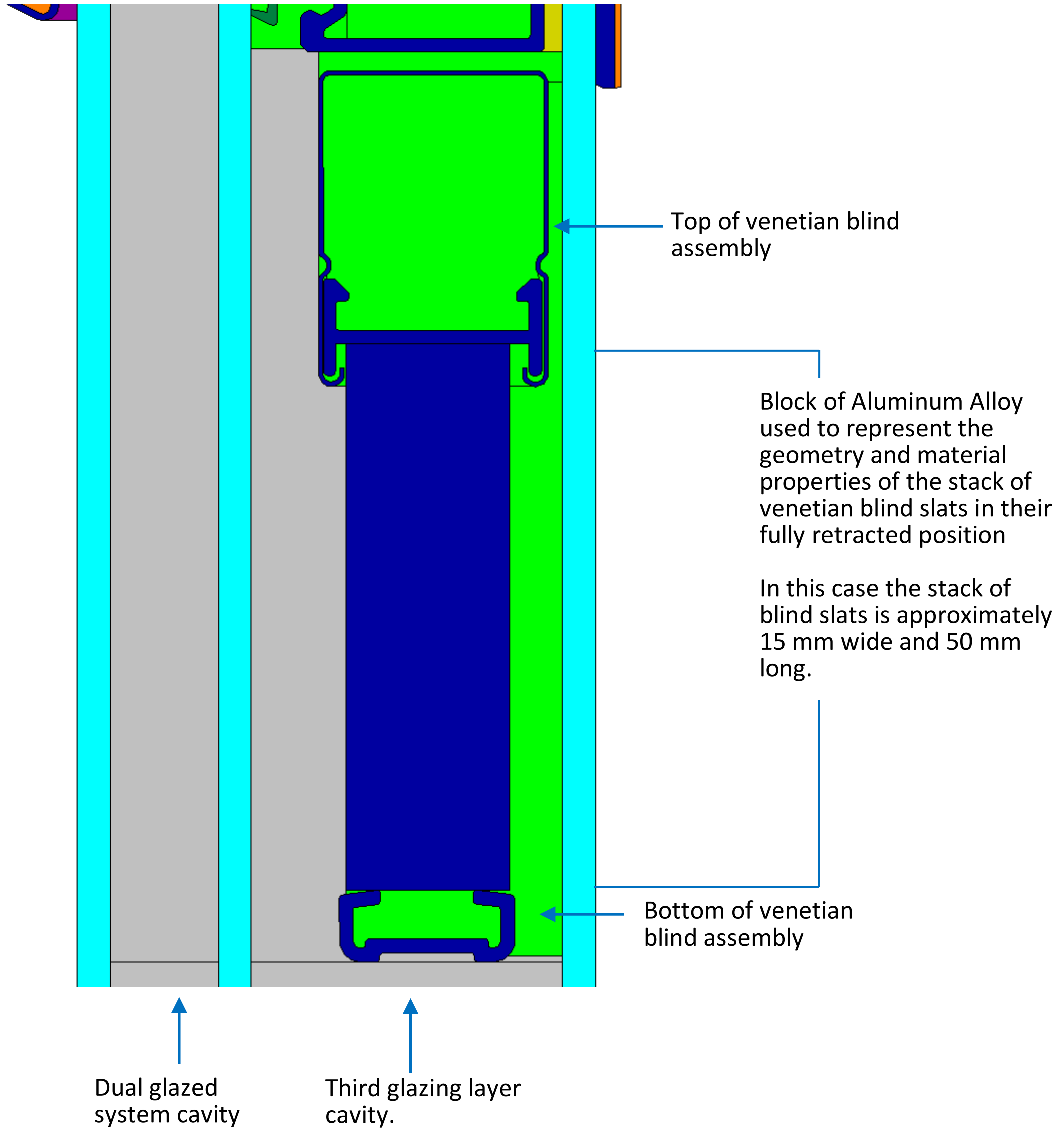


Figure 19-27. The Head cross section with the retracted venetian blind, including the stacked slats, and the top and bottom assemblies for the blind that are continuous across the section.

Follow these steps to model a fully retracted venetian blind between a double glazed system and a third glazing layer:
(Note: This example was done for Aluminum slat blinds. If the material of the blinds is not Aluminum, use the appropriate material for the stack of retracted venetian blind slats. It is possible to make a new material if needed.)

1. In THERM, draw the Head cross section of the product frame.
2. In THERM, draw the geometry of the retracted venetian blind, including the length and width of the stacked venetian blind slats and any continuous hardware that holds the blind in place (top and bottom).
3. In WINDOW, make the appropriate glazing system (in this case a triple glazed system that represents the double glazed system and a third glazing layer (such as an add-on panel)).

4. In THERM, insert the glazing system.
   The example shown below has glazing layers that intersect the frame at two different heights. There are numerous methods for modeling this. The method shown is to "stretch" the glazing layers to meet the frame at the appropriate place, and this method also necessitates inserting points on the glazing system for the correct boundary conditions segments. Another method would be to insert "float glass" polygons for the glazing layer extensions – this method eliminates the need to insert the points in the glazing system for the boundary condition segments.

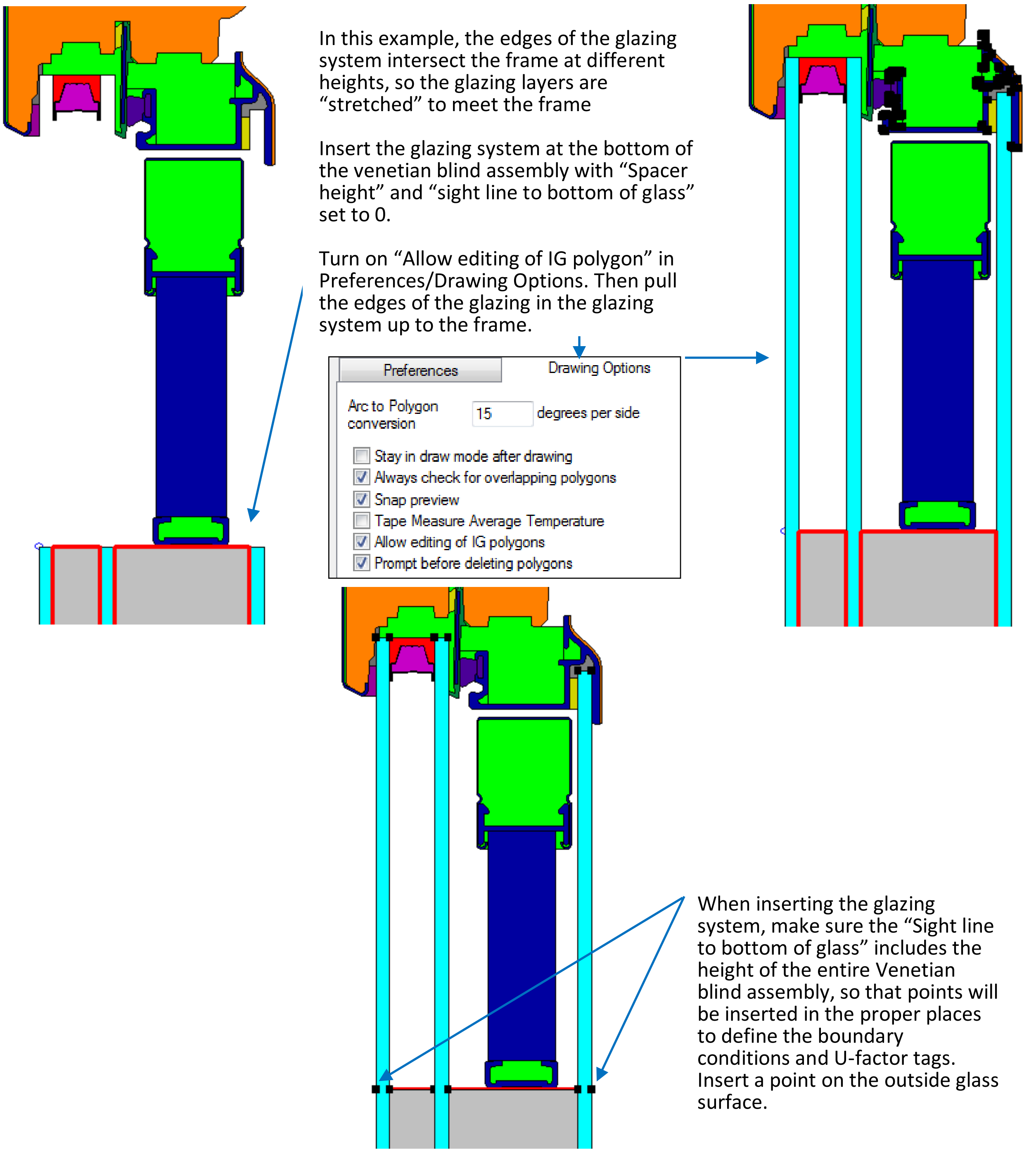


Figure 19-28. Insert the glazing system and edit it if necessary to bring the glazing layers to the frame.

5. Fill the cavities in the double glazing system and around the venetian blind in the third glazing layer with a material (any material), and then link that material to the appropriate cavity – the double glazing system cavity to the double glazing system and the third glazing layer cavity to the third glazing layer. There may be more than one area that is linked to a cavity, so make sure to link them all.

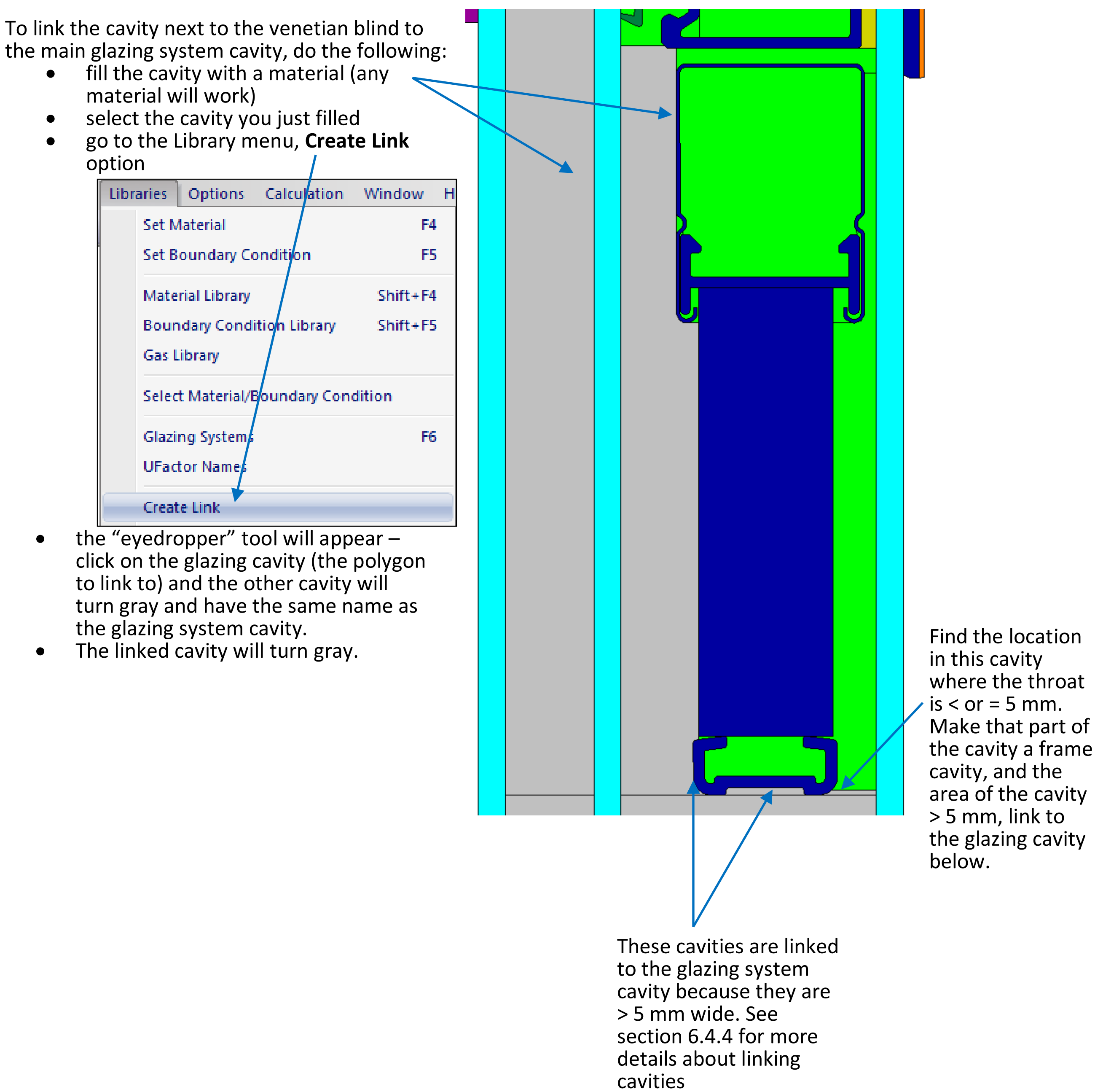


Figure 19-29. Fill the cavity next to the venetian blind by linking it to the main glazing cavity.

6. Generate the Boundary Conditions. The section of the warm side of the glazing system adjacent to the retracted venetian blind should be defined with a U-factor Surface tag of "Frame".

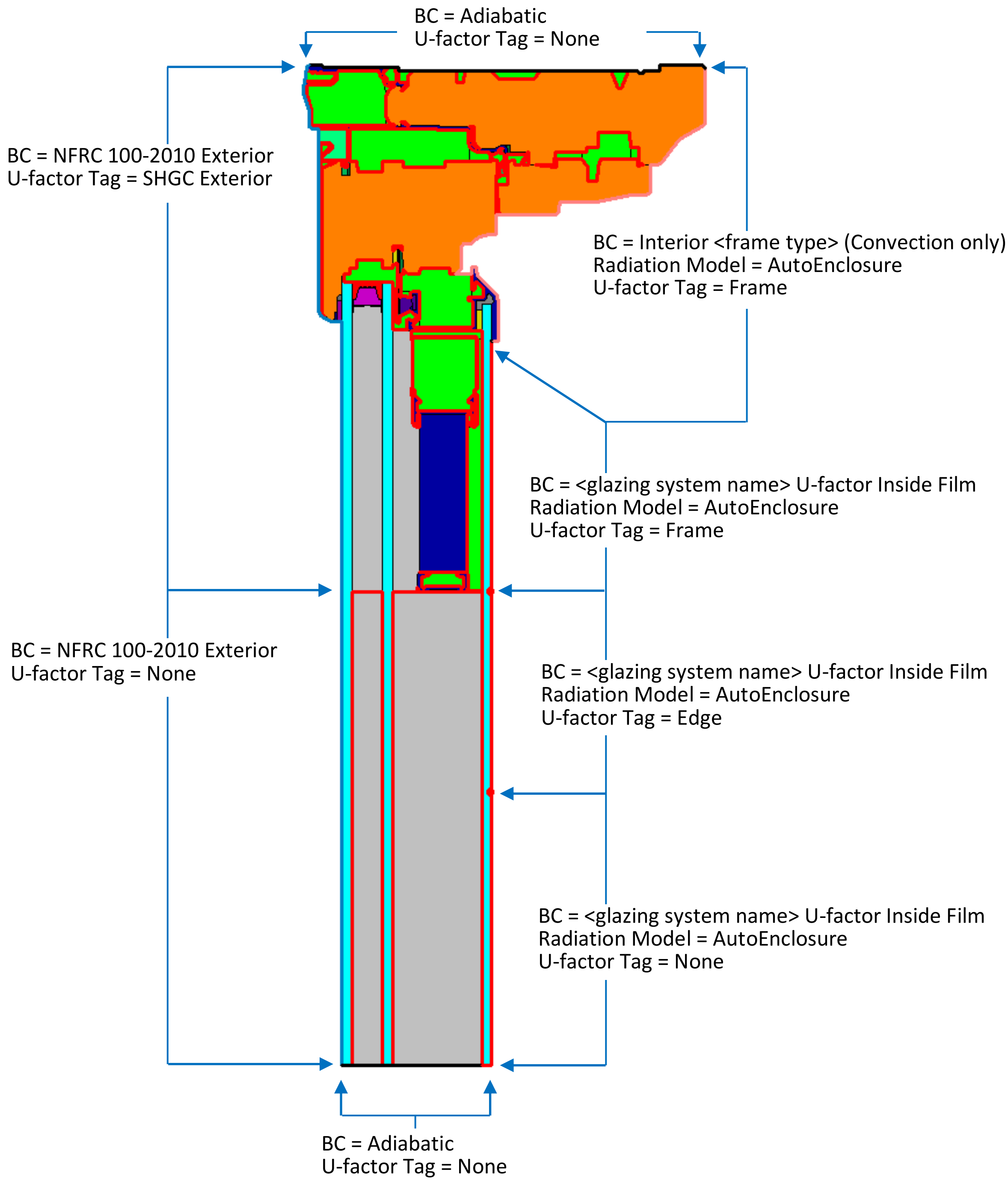
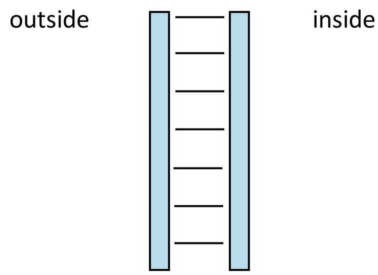


Figure 19-30. Define the boundary conditions for the cross section

7. Calculate the results for this cross section.
8. Complete the calculations for the other product cross sections (Sill, Jambs and Meeting Rails / Stiles as appropriate).
9. Import all the cross sections into the WINDOW Frame Library and calculate the total product U-value, SHGC and VT.

19.3.1.3. Non-Retractable / Open Venetian Blind Inside a Double Glazed System

Non-Retractable / Open Venetian Blind are systems that are fixed at the bottom (do not retract up), and the "open" position is defined as the blind slats set to a horizontal position, perpendicular to the plane of the glass.



In WINDOW:

1. **Shading Layer Library:** If the appropriate venetian blind product is not already in the Shading Layer Library, import it from the Complex Glazing Database (CGDB). If the product is not in the CGDB, the manufacturer will need to have the blind slat material measured and added to the CGDB before the product can be simulated.

   The Shading Layer should be defined with the venetian blind slats in a horizontal position, or as "open" as the blind geometry allows.
2. **Shade Material Library:** When the Shading Layer Library is imported from the CGDB, WINDOW will also import the associated Shade Material record for that Shade Layer into the Shade Material Library. In general, this should be automatic and you should not have to manipulate the records in the Shade Material Library.
3. **Glazing System Library:** Define the glazing system with the venetian blind between two layers of glass

In THERM:

1. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
2. **Glazing System:** Import the glazing system defined with the venetian blind (horizontal slats) into the frame geometry
3. **Boundary Conditions:** For Integral Venetian Blinds, set "Shading System Modifier" to "None"
4. Simulate the model, save the results

In WINDOW:

1. **Frame Library:** Import the THERM files into the Frame Library
2. **Window Library:** Construct the window using the THERM files from the Frame Library and the glazing system defined in Glazing System Library

These steps are illustrated in more detail in the following discussion.

In WINDOW:

1. **Shading Layer Library:** If the appropriate venetian blind product is not already in the Shading Layer Library, import it from the Complex Glazing Database (CGDB).

   In the CGDB Shading Layer Library, for Venetian blinds that are defined as Type "Venetian" (not Type "BSDF", which are currently not allowed in NFRC certification), there may be one or more definitions for the same Venetian blind product. These different records will represent different geometries of the Venetian blind, such as slat thickness, width, slat spacing and slat tilt. If you are modeling the same Venetian blind product, but with a different slat thickness, width, slat spacing or slat tilt, you can make a new Shading Layer Library and change the slat geometry.

   In this example, the Venetian blind has three records in the CGDB Shading Layer Library, representing three different slat tilts – "Closed", "45 degrees" and "Open".

Shading Layer Library (C:\Users\Public\LBNL\WINDOW7.7\w7.mdb)

ID	Name	ProductName	Manufacture	Type	Material	PermeabilityFactor
3000	Slim White VB Closed	Slim White Venetian Blind	Pella	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.955
3001	Slim White VB 45	Slim White Venetian Blind	Pella	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.989
3002	Slim White Open	Slim White Venetian Blind	Pella	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.992
3003	Slim Marine Closed	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)	Marine Venetian Blind Slat (marine.txt)	0.992
3004	Slim Marine 45	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)	Marine Venetian Blind Slat (marine.txt)	0.989
3005	Slim Marine Open	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)	Marine Venetian Blind Slat (marine.txt)	0.992

Figure 19-31. Import the appropriate records from the CGDB Shading Layer Library

If only one slat geometry is represented in the CGDB (such as open or closed), import that record into the working database, and then make new records for the missing slat geometries, so that there is a separate Shading Layer record for both the Open and Closed geometries.

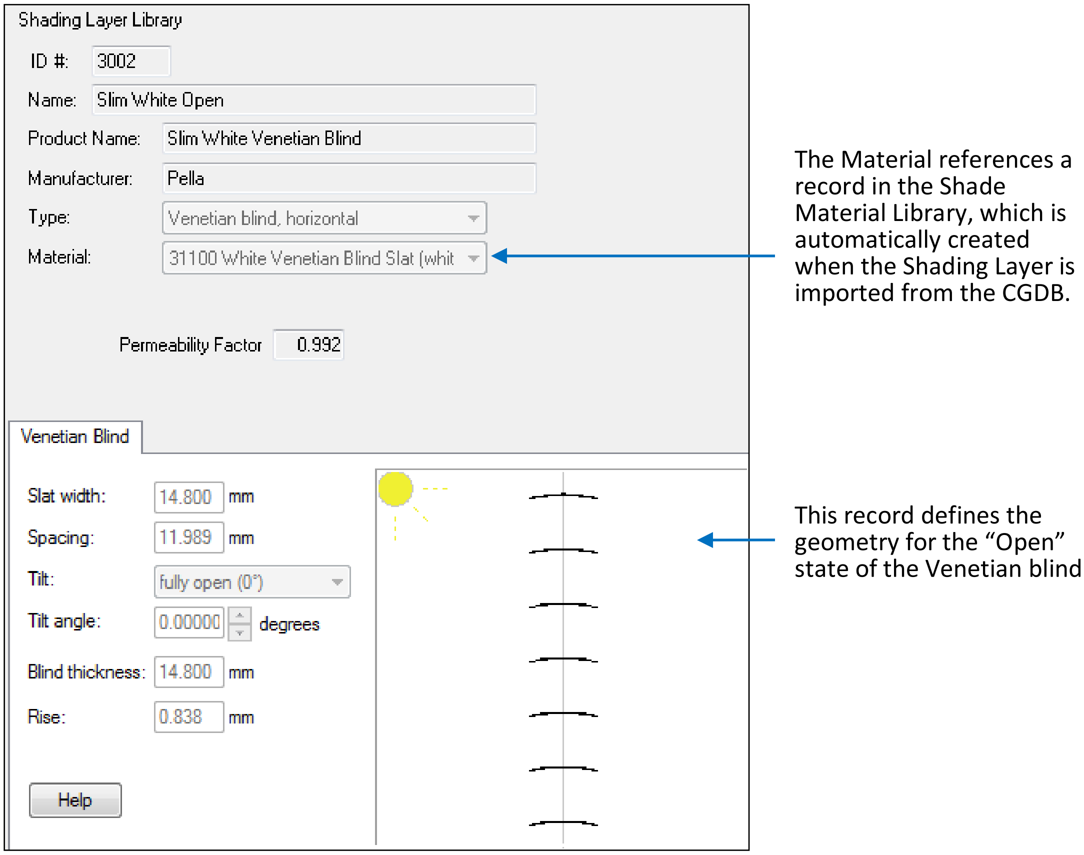


Figure 19-32. Define the venetian blind geometry for the "open" (horizontal) slats

- **Type**: Venetian blind, horizontal
- **Material**: White Venetian Blind Slat; this pulldown references the record in the Material Library that is associated with this Shading Layer. When a Shading Layer is imported from the CGDB, the associated record for the material is automatically added to the Shade Material Library. If you need to make a new Shading Layer record for a different slat geometry, make sure to reference the same material record in the Shade Material Library.
- **Effective Openness Fraction:** If a Shading Layer is imported from the CGDB, this value will automatically be set. If you are making a new record, the Effective Openness Fraction = 1 for the "Open" blind case.
- **Slat Width:** appropriate value, in this example 14.8 mm
- **Spacing** = spacing between each slat, in this example 12 mm

- **Tilt:** "fully open (0º)" for a slat in the horizontal position

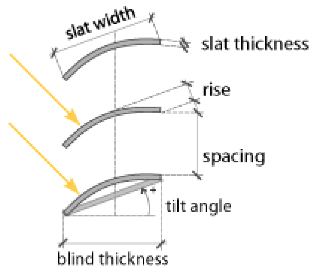


Figure 19-33. Venetian blind geometry definition

- **Blind thickness**: This value is not editable, and shows the width of the blind "assembly" based on the slat tilt. In this "Open" case, the blind thickness will equal the slat width. At any other slat angle, this value will be less than the slat width.
- **Rise:** this value defines the curve of the slat, and is defined in the CGDB for each Venetian blind product. It can be changed if it does not represent the slat curvature being modeled – this would be necessary if the slat width was changed, for example.

2. **Shade Material Library:** When a Shading Layer record is imported from the CGDB, the Shad e Material is automatically imported, and therefore it is not necessary to add or change records in the Shade Material Library. However, you may need to reference existing records in the Shade Material Library if you are defining a new Shading Layer record (for example to define a differen slat geometry for a product).

Shade Material Library (C:\Users\Public\LBNL\WINDOW7.7\w7.mdb)

	ID	Name	ProductName	Manufacturer	Source	Mode
	31100	White Venetian Blind Slat (white.txt)	White Venetian Blind Slat	Pella	CGDB	
	31107	Marine Venetian Blind Slat (marine.txt)	Marine Venetian Blind Slat	Pella	CGDB	#

Figure 19-34. Shade Material Library records are automatically created when Shading Layers are imported from the CGDB.

Glazing System Library: Define the glazing system with the venetian blind between two layers of glass

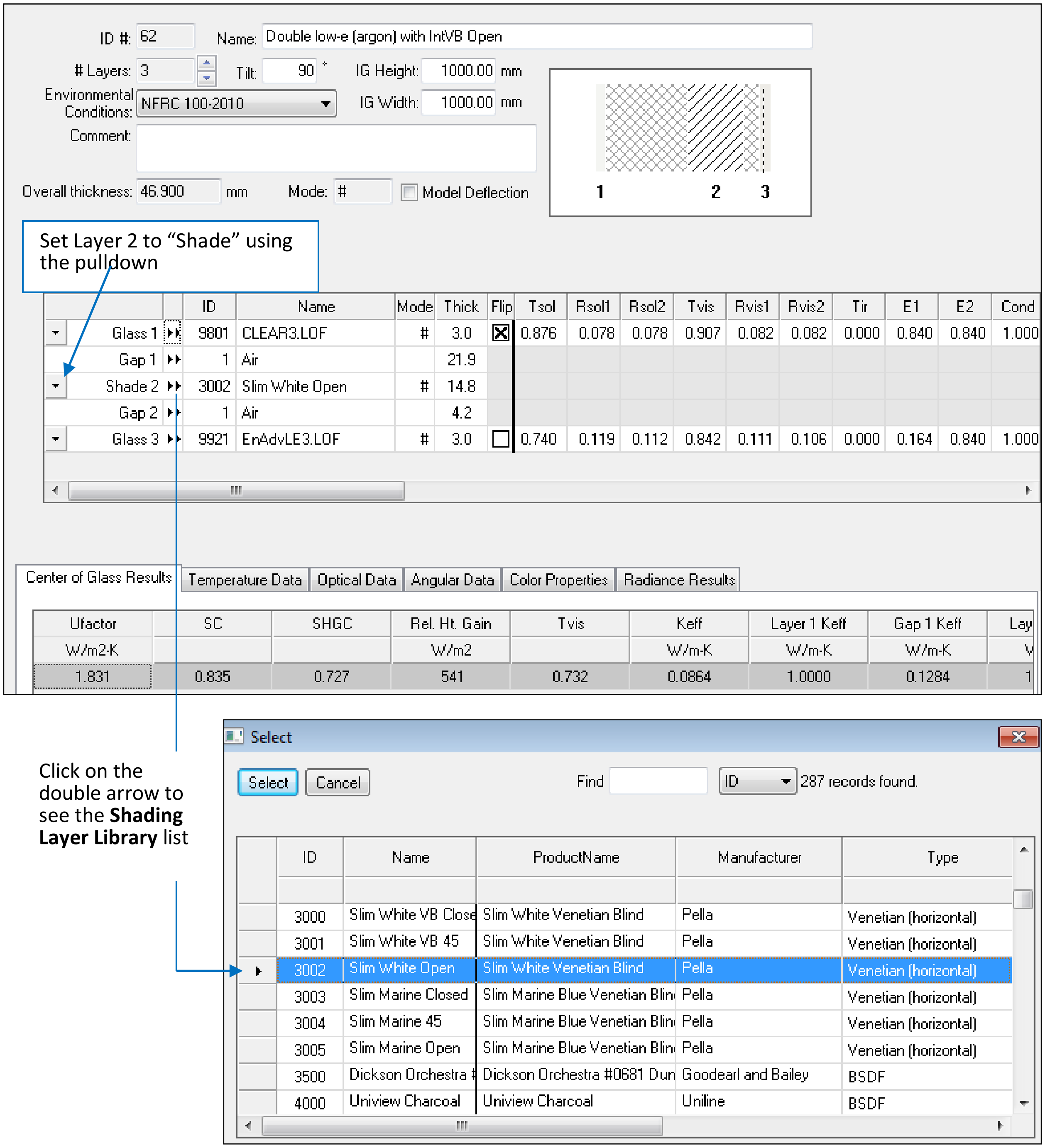


Figure 19-35. For the middle layer in the Glazing System (Layer #2), select the venetian blind from the Shading System Library.

- Set Number of layers = 3
- Set **Layer #2** to “Shade” (from pulldown arrow to the left in the first column)
- Set **Dtop**, **Dbot**, **Dright**, **Dleft** to the appropriate values for the venetian blind geometry. These distances are based on the distance between the top of the venetian blind (including hardware) and the top (or left, right, bottom) of the glazing system.

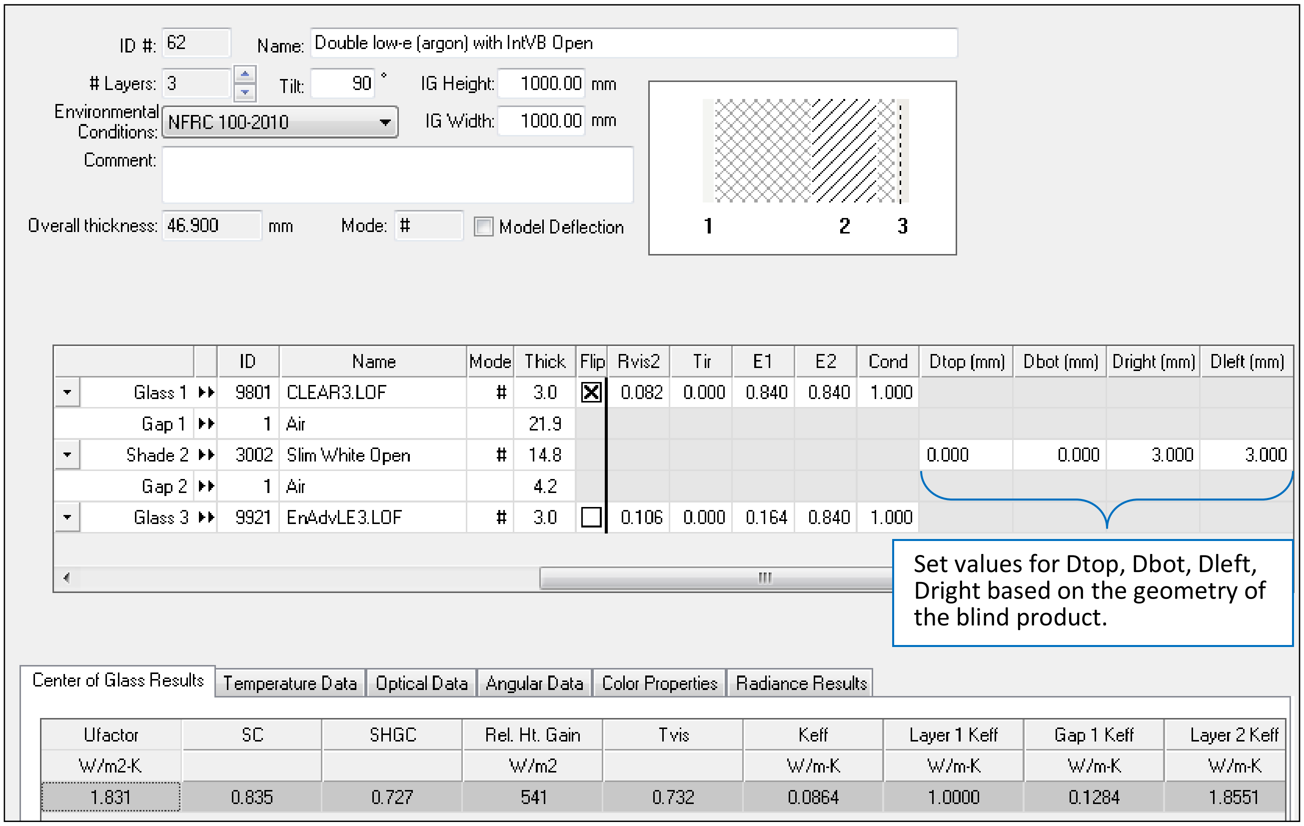


Figure 19-36. Define a Dtop, Dbot, Dleft and Dright in the Glazing System Library.

In THERM:

1. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
2. **Glazing System:** Import the glazing system defined with the venetian blind (horizontal slats) into the frame geometry. For this example, the Head cross section, the following settings were used in the Insert Glazing System dialog box:
    - **Orientation:** Down (for the Head cross section
    - **Cross Section Type:** Head
    - **Spacer Height:** 0 or 38.826 mm
      You can use the spacer height value to make room for the Venetian blind hardware, or you can set it to zero and pull the glass layers into the frame (make sure Options/Preferences/Drawing Options has "Allow Editing of IG Polygons" checked).
    - **Sight Line to bottom of glass:** The sightline is defined by the edge of the venetian blind hardware.
    - **Sight line to shade edge:** In this case the value = 0.

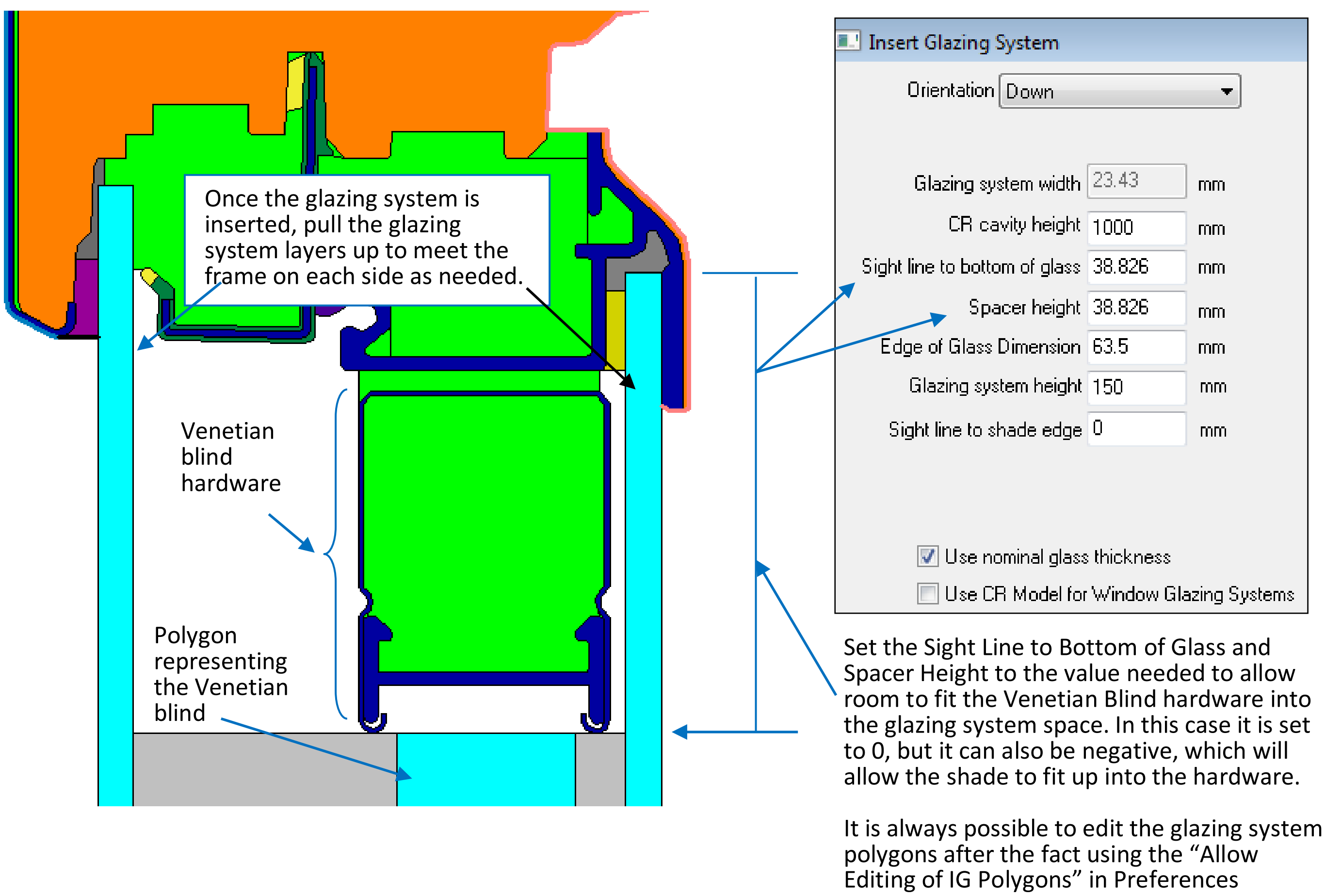


Figure 19-37. Insert the glazing system with the Venetian blind

Fill in the remaining cavities and either model them as NFRC Frame Cavities or link them to the appropriate glazing system cavity.

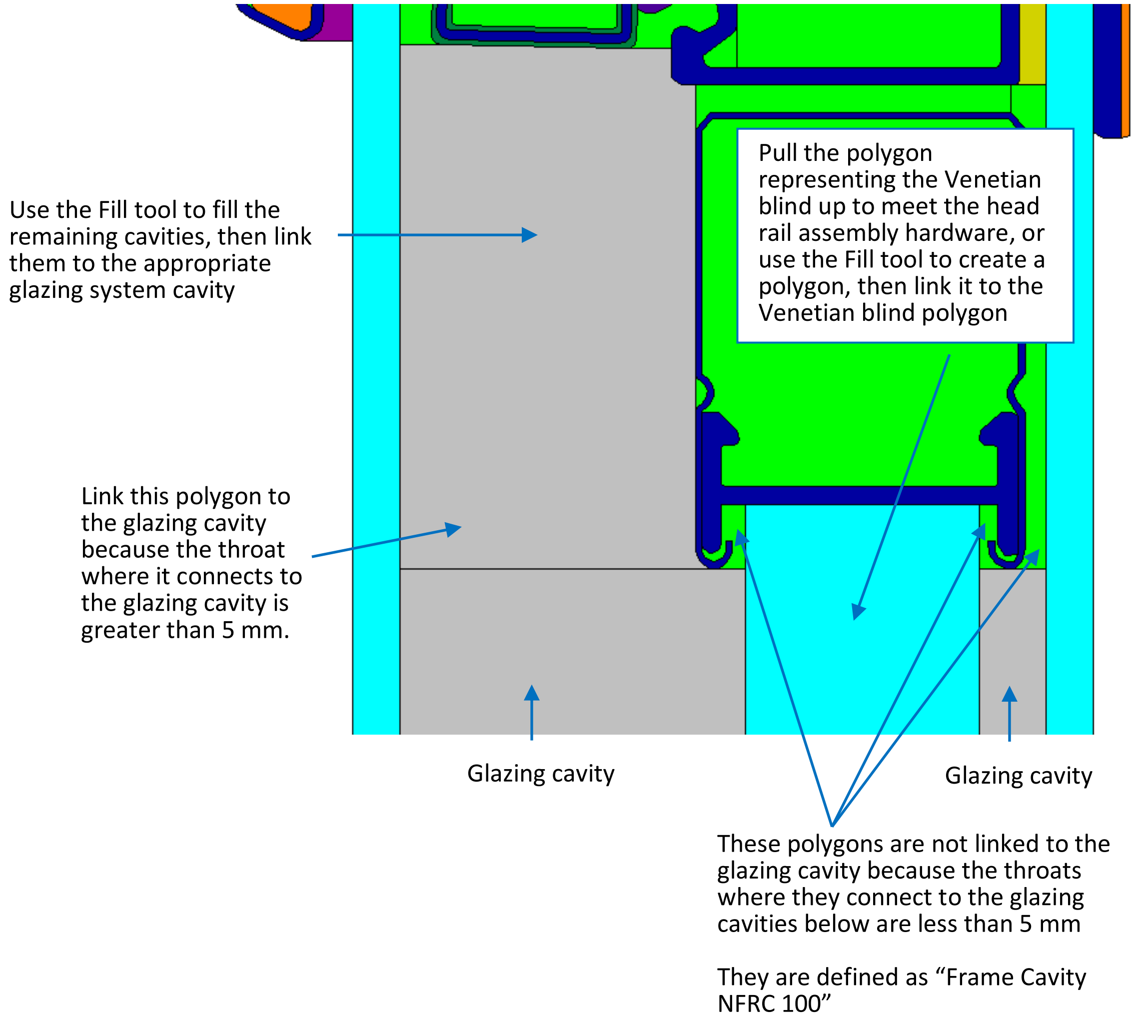


Figure 19-38. Fill the remaining cavities and link to the appropriate glazing system cavities.

3. Create the other cross sections in this manner.

   In the case of the Head and Sill cross sections, the Sight Line to Shade Edge is zero. However, for the Jamb cross section, the blind does not touch the edge of the frame, but rather is 3 mm off the frame, so the Sight Line to Shade Edge is non-zero.

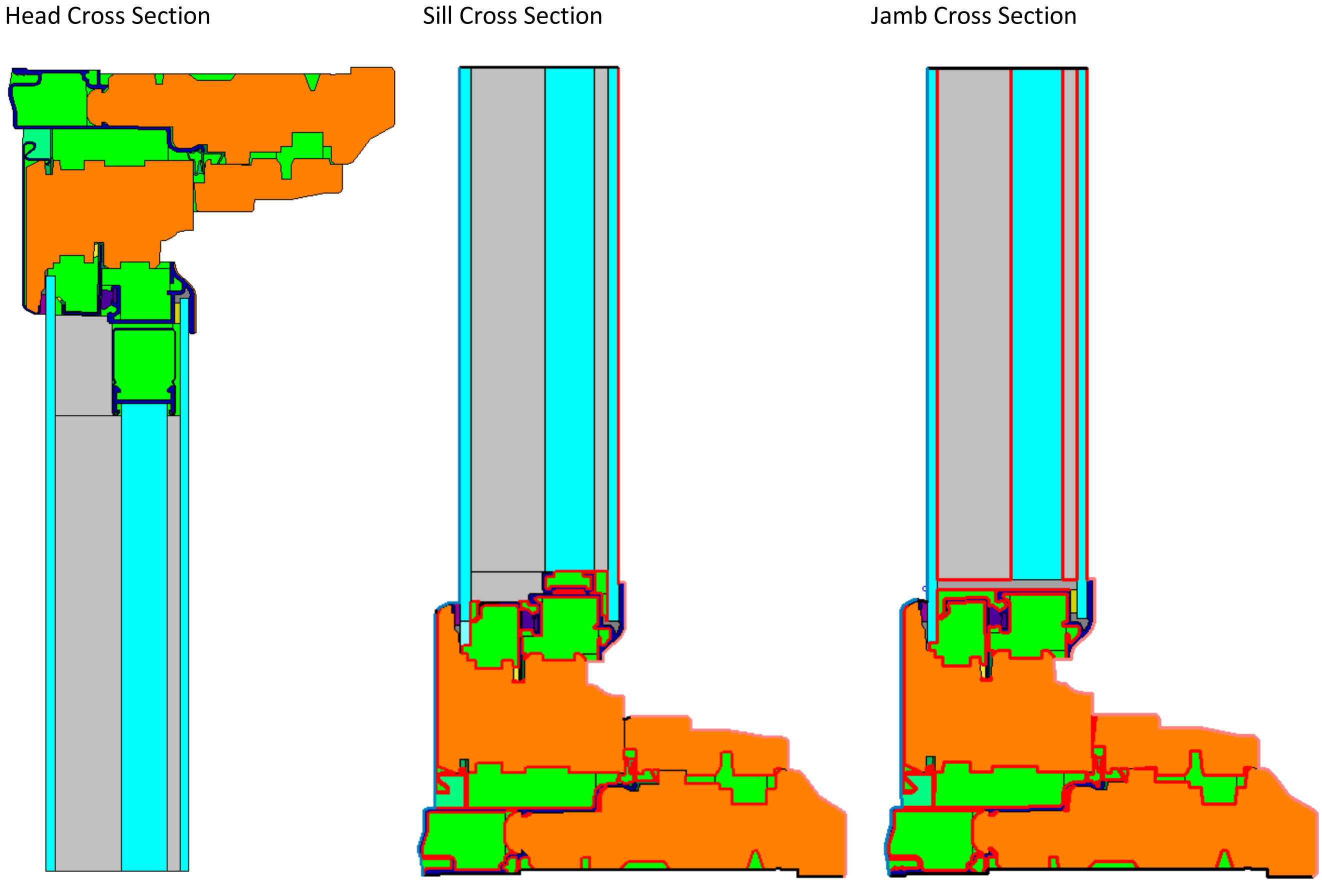


Figure 19-39. Head, Sill and Jamb cross sections for Non-retractable Open Venetian Blind between glass layers (Integral)

4. **Boundary Conditions:** The program will not automatically insert a point in the exterior glass layer for the SHGC Exterior U-factor tag, so you will need to do that by hand by editing the glazing system. For Integral Venetian Blinds, the **Shading System Modifier** choice will automatically be set to "None"

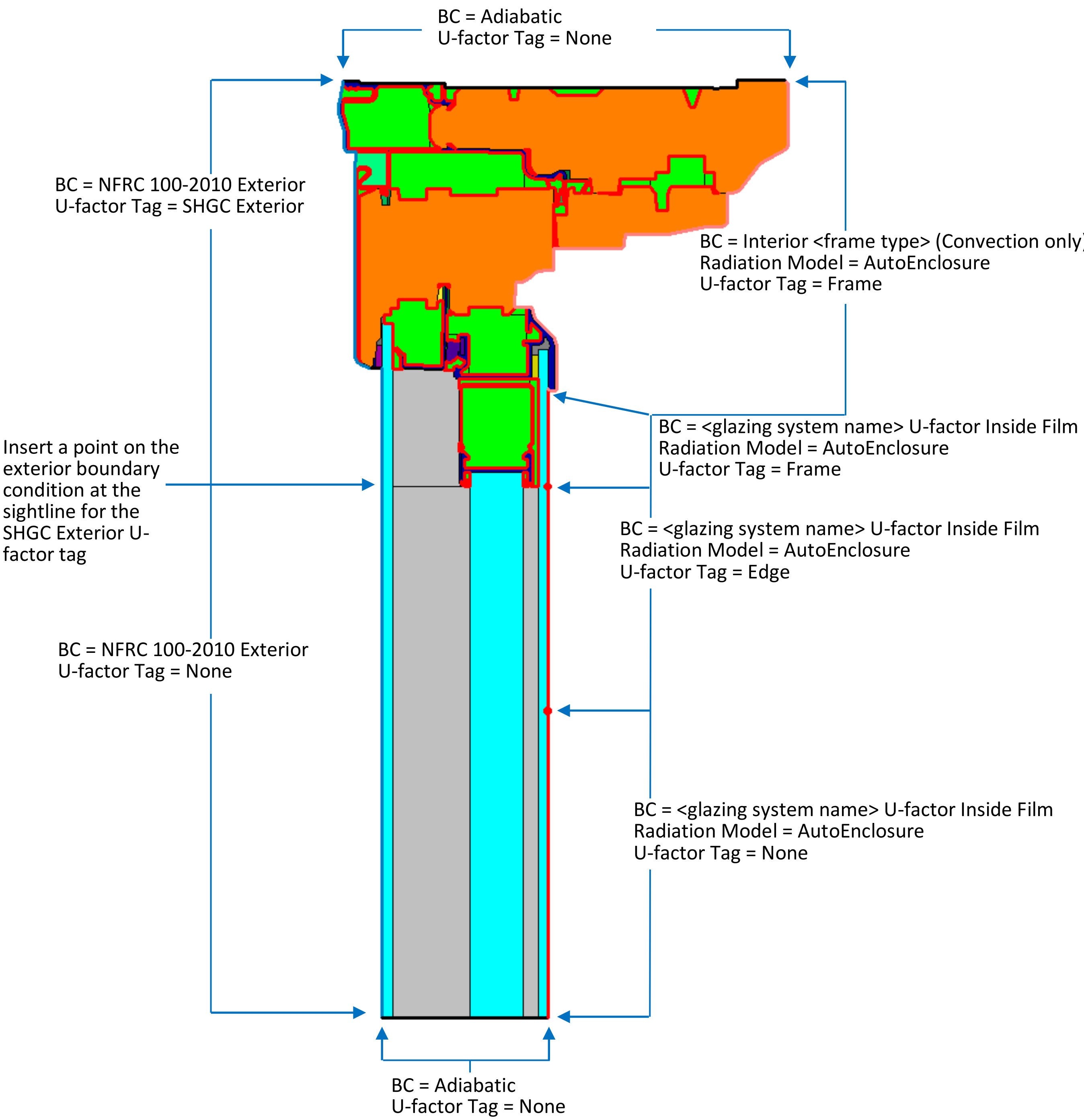


Figure 19-40. Define the boundary conditions for the Head Non-Retractable Open Venetian Blind cross section

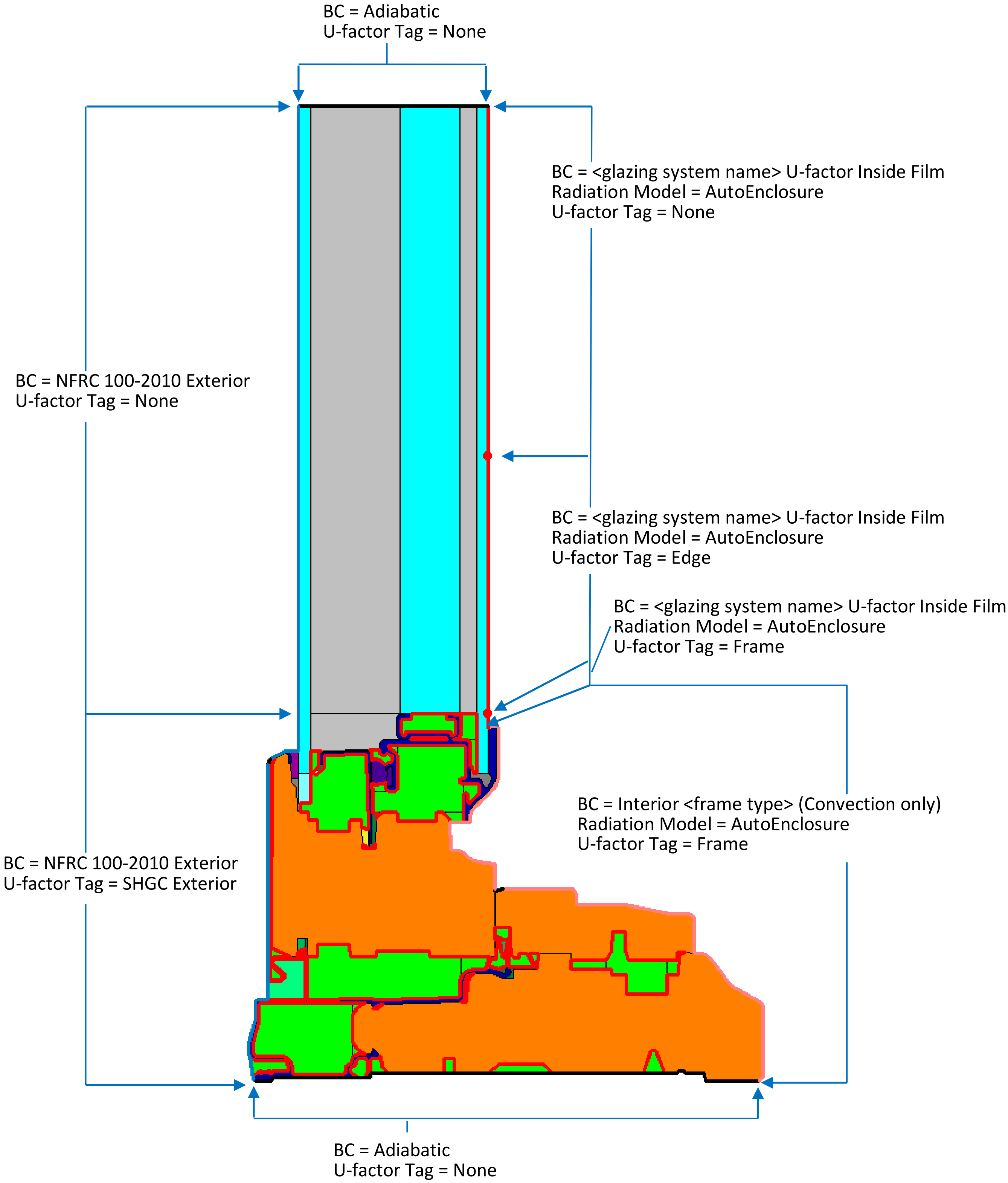


Figure 19-41. Define the boundary conditions for each Sill Non-Retractable Open Venetian Blind cross section

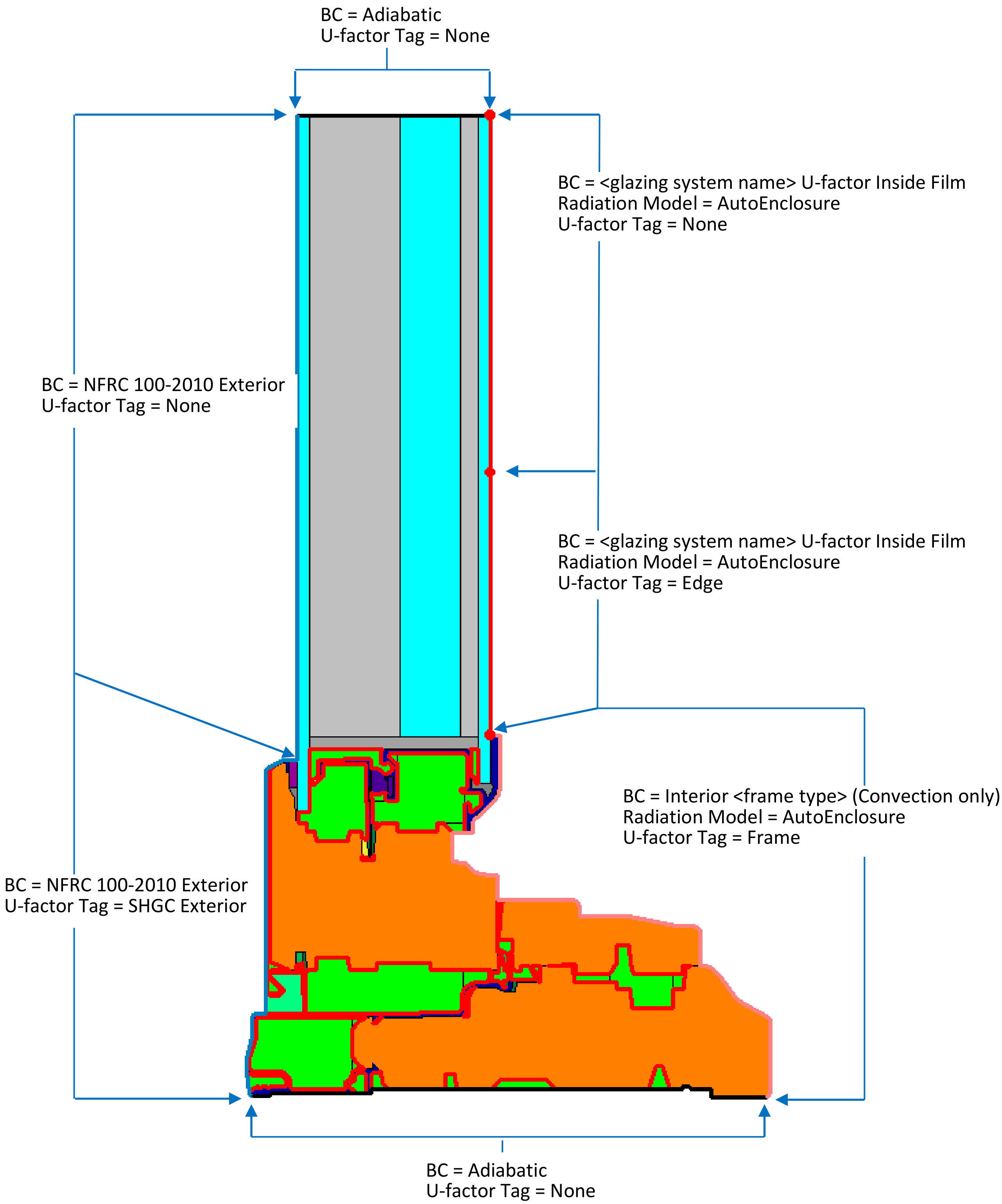
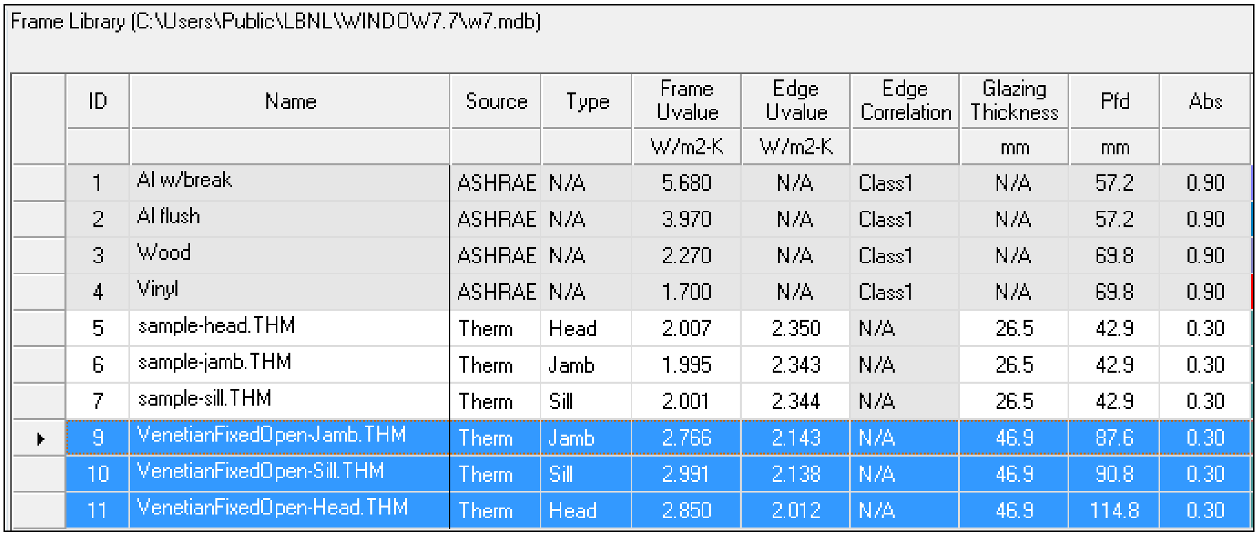


Figure 19-42. Define the boundary conditions for each Jamb Non-Retractable Open Venetian Blind cross section

5. Simulate each cross section and save the results.

In WINDOW:

1. **Frame Library:** Import the THERM files into the Frame Library



Frame Library (C:\Users\Public\LBNL\WINDOW7.7\w7.mdb)

ID	Name	Source	Type	Frame Uvalue W/m2-K	Edge Uvalue W/m2-K	Edge Correlation	Glazing Thickness mm	Pfd mm	Abs
1	Al w/break	ASHRAE	N/A	5.680	N/A	Class1	N/A	57.2	0.90
2	Al flush	ASHRAE	N/A	3.970	N/A	Class1	N/A	57.2	0.90
3	Wood	ASHRAE	N/A	2.270	N/A	Class1	N/A	69.8	0.90
4	Vinyl	ASHRAE	N/A	1.700	N/A	Class1	N/A	69.8	0.90
5	sample-head.THM	Therm	Head	2.007	2.350	N/A	26.5	42.9	0.30
6	sample-jamb.THM	Therm	Jamb	1.995	2.343	N/A	26.5	42.9	0.30
7	sample-sill.THM	Therm	Sill	2.001	2.344	N/A	26.5	42.9	0.30
9	VenetianFixedOpen-Jamb.THM	Therm	Jamb	2.766	2.143	N/A	46.9	87.6	0.30
10	VenetianFixedOpen-Sill.THM	Therm	Sill	2.991	2.138	N/A	46.9	90.8	0.30
11	VenetianFixedOpen-Head.THM	Therm	Head	2.850	2.012	N/A	46.9	114.8	0.30

Figure 19-43. Import the THERM files into the WINDOW Frame Library

2. **Window Library:** Construct the window using the THERM files in the Frame Library and the glazing system defined in Glazing System Library

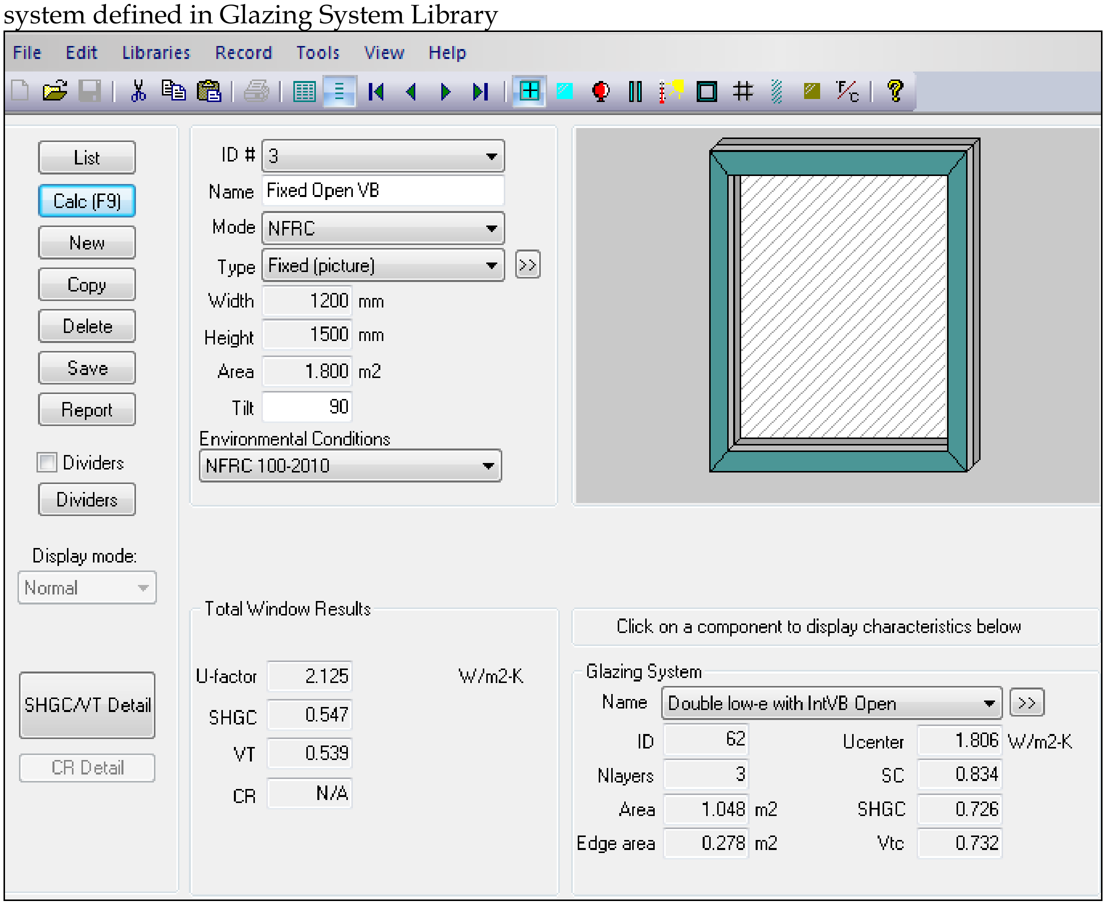


Figure 19-44. Define and calculate the window.

19.3.2. Closed Venetian Blind

This section describes modeling a Venetian blind in it's closed position. The modeling procedures presented here will apply to either a retractable or non-retractable Venetian blind.

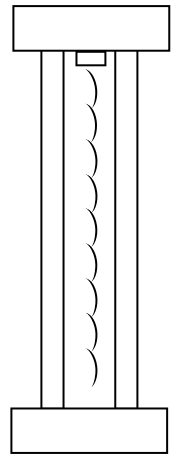


Figure 19-45. A closed Venetian blind between two glass layers.

In WINDOW:

1. **Shading Layer Library:** If the appropriate venetian blind product is not already in the Shading Layer Library, import it from the Complex Glazing Database (CGDB). If the product is not in the CGDB, the manufacturer will need to have the blind slat material measured and added to the CGDB before the product can be simulated.

   The Shading Layer should be defined with the venetian blind slats in a vertical position, or as "closed" as the blind geometry allows.
2. **Shade Material Library:** When the Shading Layer Library is imported from the CGDB, WINDOW will also import the associated Shade Material record for that Shade Layer into the Shade Material Library. In general, this should be automatic and you should not have to manipulate the records in the Shade Material Library
3. **Glazing System Library:** Define the glazing system with the venetian blind between two layers of glass

In THERM:

1. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
2. **Glazing System:** Import the glazing system defined with the venetian blind (vertical "closed" slats) into the frame geometry
3. **Boundary Conditions:** For Integral Venetian Blinds, set "Shading System Modifier" to "None"
4. Simulate the model, save the results

In WINDOW:

5. **Frame Library:** Import the THERM files into the Frame Library
6. **Window Library:** Construct the window using the THERM files in the Frame Library and the glazing system defined in Glazing System Library

These steps are illustrated in more detail in the following discussion.

In WINDOW:

1. **Shading Layer Library:** If the appropriate venetian blind product is not already in the Shading Layer Library, import it from the Complex Glazing Database (CGDB).

   In the CGDB Shading Layer Library, for Venetian blinds that are defined as Type "Venetian" (and not Type "BSDF"), there may be one or more definitions for the same Venetian blind product. These different records will represent different geometries of the Venetian blind, such as slat thickness, width and slat spacing. However, if you are modeling the same Venetian blind product, but with a different slat thickness, width or slat spacing, you can make a new Shading Layer Library and change the slat geometry.

   In this example, the Venetian blind has three records in the CGDB Shading Layer Library, representing three different slat tilts – "Closed", "45 degrees" and "Open". For NFRC certification, the 45 degree geometry is not needed, and therefore only the "Closed" and "Open" records are imported from the CGDB, as shown in the figure below.

Shading Layer Library (C:\Users\Public\LBNL\WINDOW7.7\w7.mdb)

ID	Name	ProductName	Manufacturer	Type	Material	PermeabilityFactor
3000	Slim White VB Closed	Slim White Venetian Blind	Pella	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.955
3001	Slim White VB 45	Slim White Venetian Blind	Pella	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.989
3002	Slim White Open	Slim White Venetian Blind	Pella	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.992
3003	Slim Marine Closed	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)	Marine Venetian Blind Slat (marine.txt)	0.992
3004	Slim Marine 45	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)	Marine Venetian Blind Slat (marine.txt)	0.989
3005	Slim Marine Open	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)	Marine Venetian Blind Slat (marine.txt)	0.992

Figure 19-46. Import the appropriate records from the CGDB Shading Layer Library

If only one slat geometry is represented in the CGDB, import that record into the working database, and then make new records for the missing slat geometries, so that there is a separate Shading Layer record for both the Open and Closed geometries.

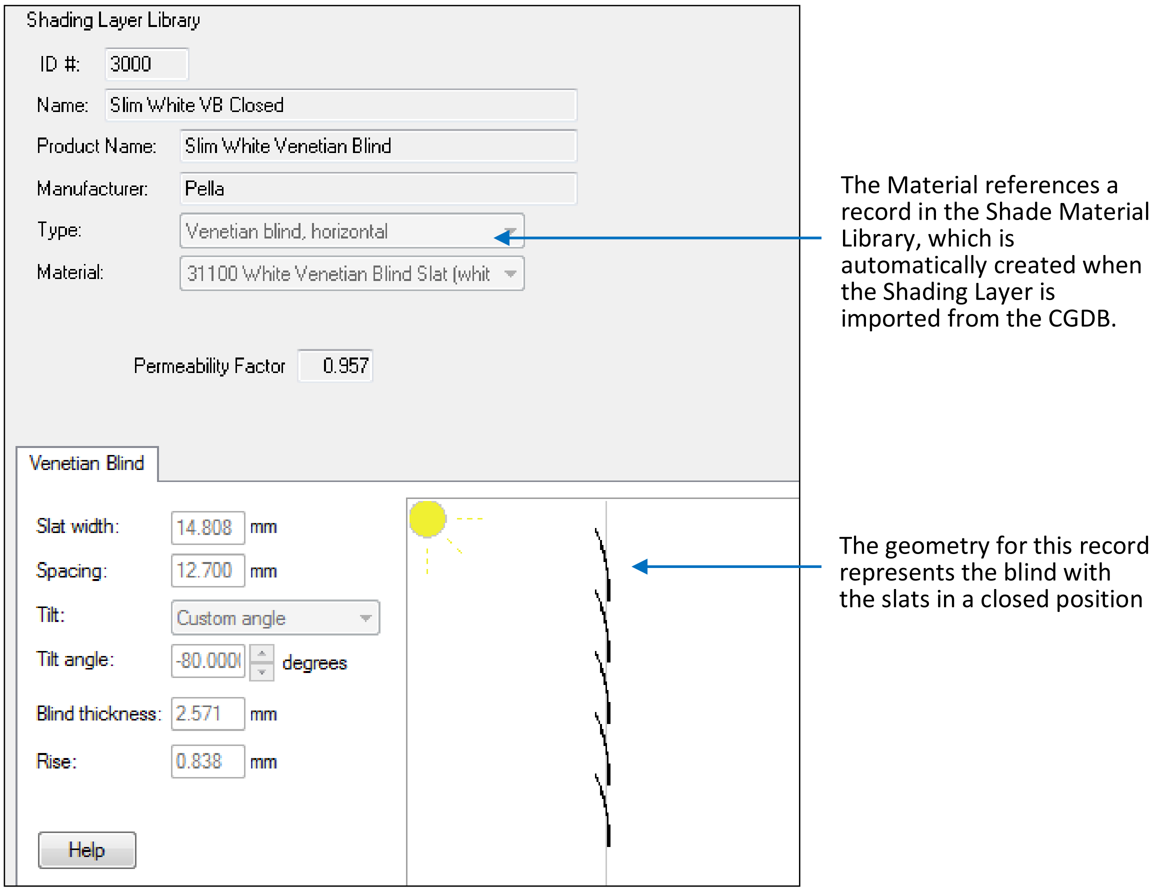


Figure 19-47. Define the venetian blind geometry for the "closed" (vertical) slats

- **Type**: Venetian blind, horizontal
- **Material**: White Venetian Blind Slat; this pulldown references the record in the Material Library that is associated with this Shading Layer. When a Shading Layer is imported from the CGDB, the associated record for the material is automatically added to the Shade Material Library. If you need to make a new Shading Layer record for a different slat geometry, make sure to reference the same material record in the Shade Material Library.
- **Effective Openness Fraction/Permeability Factor:** The value is calculated based on the geometry of the layer
- **Slat Width:** appropriate value, in this example 14.8 mm
- **Spacing** = spacing between each slat, in this example 12 mm

- **Tilt:** "closed (-90)" or "closed (+90)" depending on the product geometry. If the shade is not capable of reaching 90 at full tilt then the appropriate maximum achievable tilt is entered under "Custom angle".

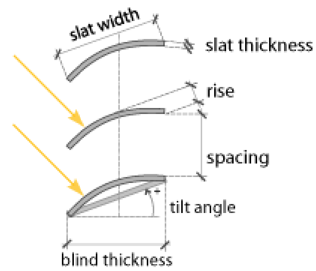


Figure 19-48. Venetian blind geometry definition

- **Blind thickness**: This value is not editable, and shows the width of the blind "assembly" based on the slat tilt. In this "Closed" case, the blind thickness is very small.
- **Rise:** this value defines the curve of the slat, and is defined in the CGDB for each Venetian blind product. It can be changed if it does not represent the slat curvature being modeled – this would be necessary if the slat width was changed, for example.

2. **Shade Material Library:** When a Shading Layer record is imported from the CGDB, the Shade Material is automatically imported, and therefore in general, it is not necessary to add or change records in the Shade Material Library. However, you may need to reference existing records in the Shade Material Library if you are defining a new Shading Layer record (for example to define a differen slat geometry for a product).

Shade Material Library (C:\Users\Public\LBNL\WINDOW7.7\w7.mdb)

	ID	Name	ProductName	Manufacturer	Source	Mode
▸	31100	White Venetian Blind Slat (white.txt)	White Venetian Blind Slat	Pella	CGDB	
	31107	Marine Venetian Blind Slat (marine.txt)	Marine Venetian Blind Slat	Pella	CGDB	#

Figure 19-49. Shade Material Library records are automatically created when Shading Layers are imported from the CGDB.

Glazing System Library: Define the glazing system with the venetian blind between two layers of glass

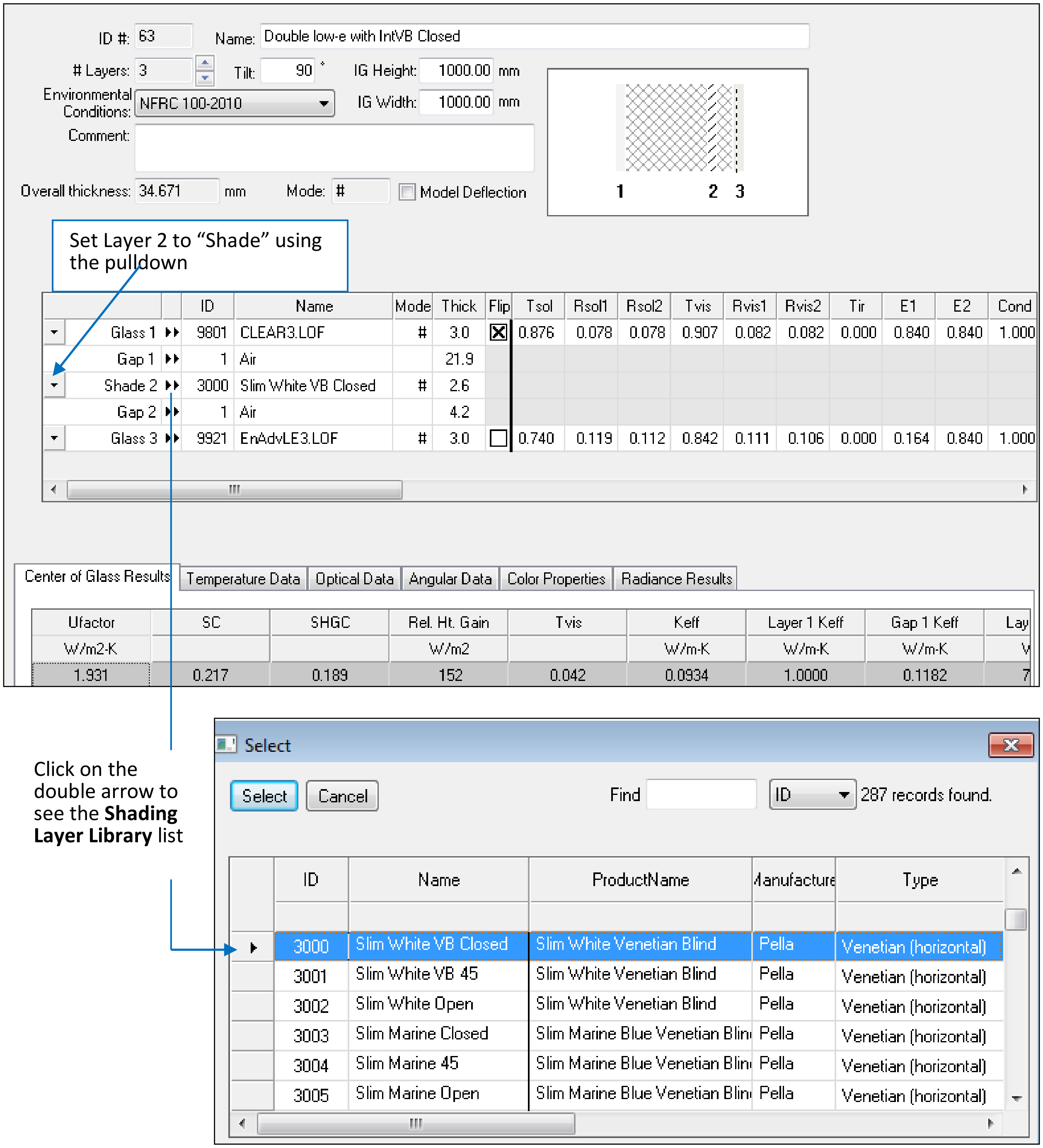


Figure 19-50. For the middle layer in the Glazing System (Layer #2), select the venetian blind from the Shading System Library.

- Set Number of layers = 3
- Set **Layer #2** to "Shade" (from pulldown arrow to the left in the first column)
- Set **Dtop**, **Dbot**, **Dright**, **Dleft** to the appropriate values for the venetian blind geometry

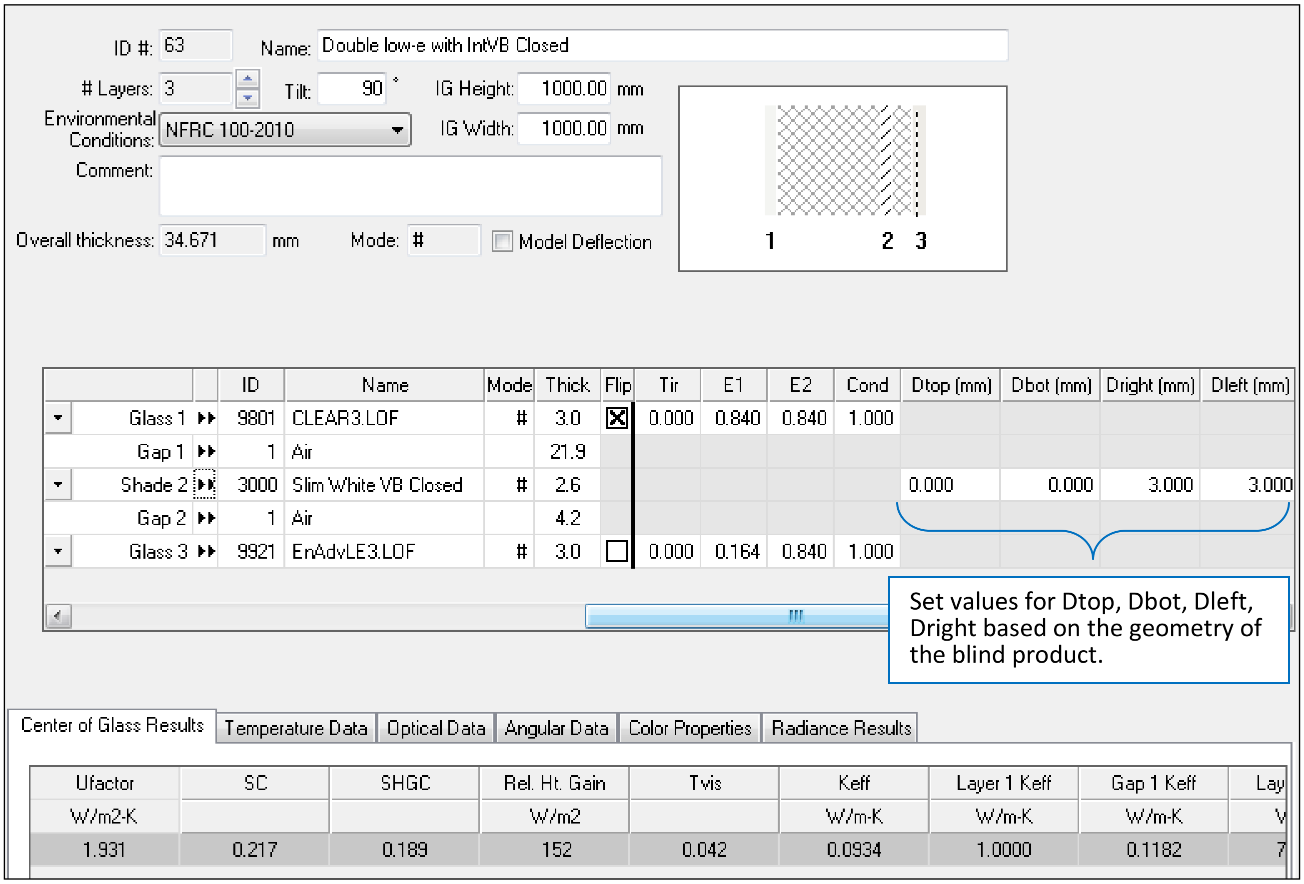


Figure 19-51. Define a Dtop, Dbot, Dleft and Dright in the Glazing System Library.

In THERM:

1. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
2. **Glazing System:** Import the glazing system defined with the venetian blind (horizontal slats) into the frame geometry. For this example, the Head cross section, the following settings were used in the Insert Glazing System dialog box:
    - Orientation: **Down** (for the Head cross section
    - Cross Section **Type: Head**
      Setting the Cross Section Type to the approriate value allows THERM to automatically insert a polygon in the correct place for the Dtop (for Head), Dbottom (for Sill), Dright (for Right Jamb) and Dleft (for Left Jamb).
    - Spacer Height: **0**
      In this case, it was easiest to set the spacer height to 0 and pull the sides of the glazing sysetm layers up to the frame on each side (make sure Options/Preferences/Drawing Options has "Allow Editing of IG Polygons" checked).

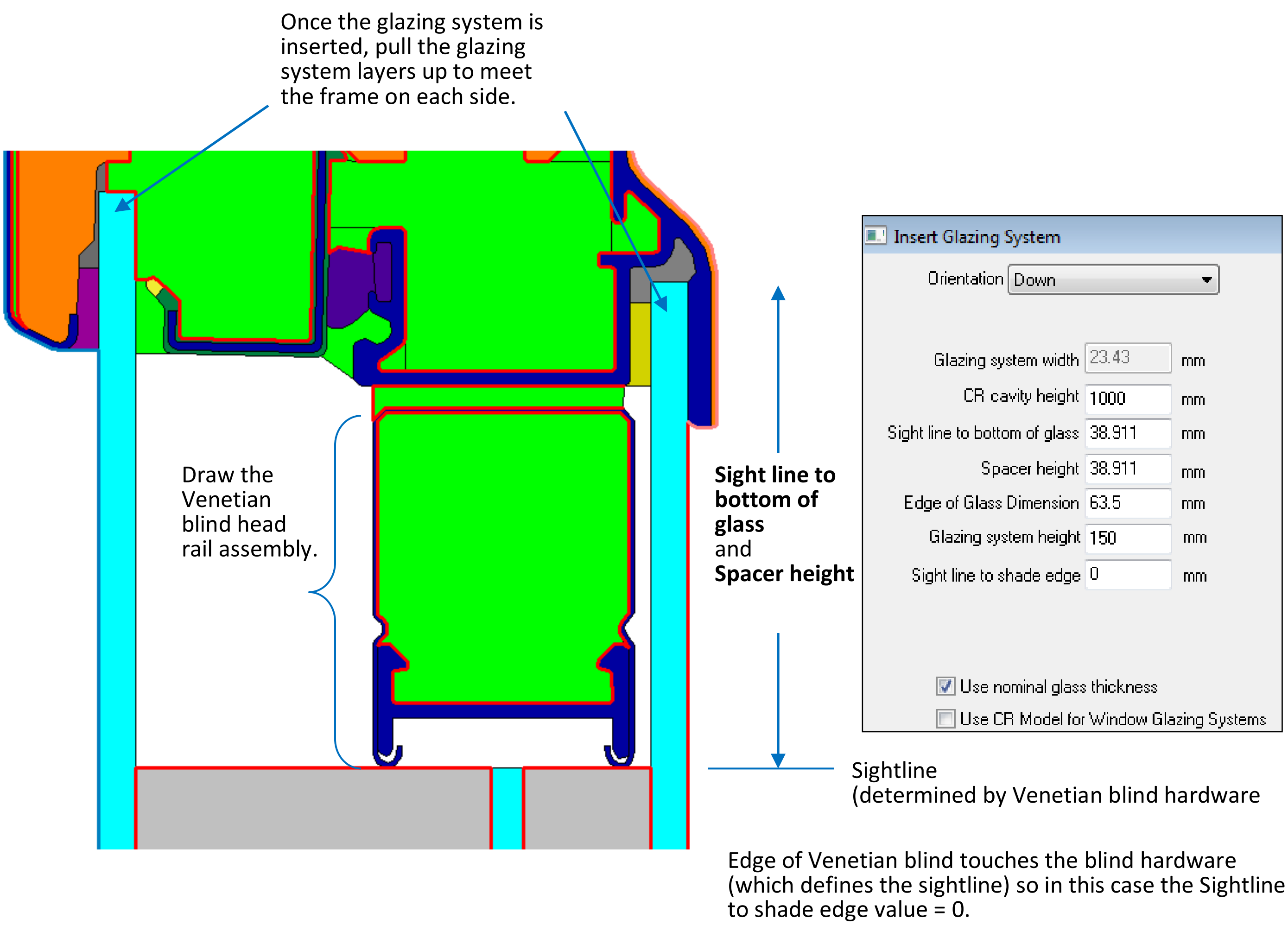


Figure 19-52. Insert the glazing system with the Venetian blind

Add Venetian Blind Hardware: Add the head rail assembly of the venetian blind between the polygon representing Dtop and the polygon representing the Venetian blind.

Fill in the remaining cavities by linking them to the appropriate glazing system cavity.

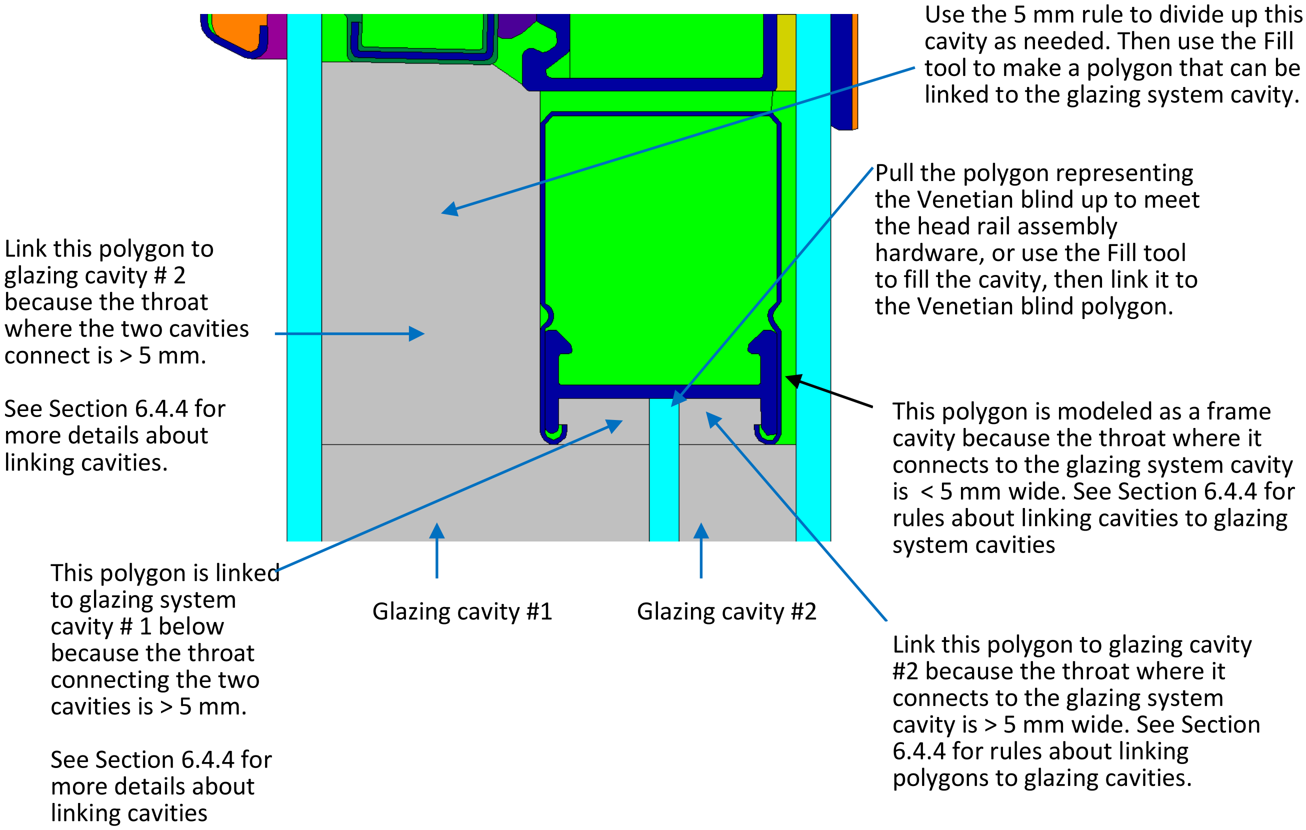


Figure 19-53. Fill the remaining cavities and link to the appropriate glazing system cavities.

Create the other cross sections in this manner.

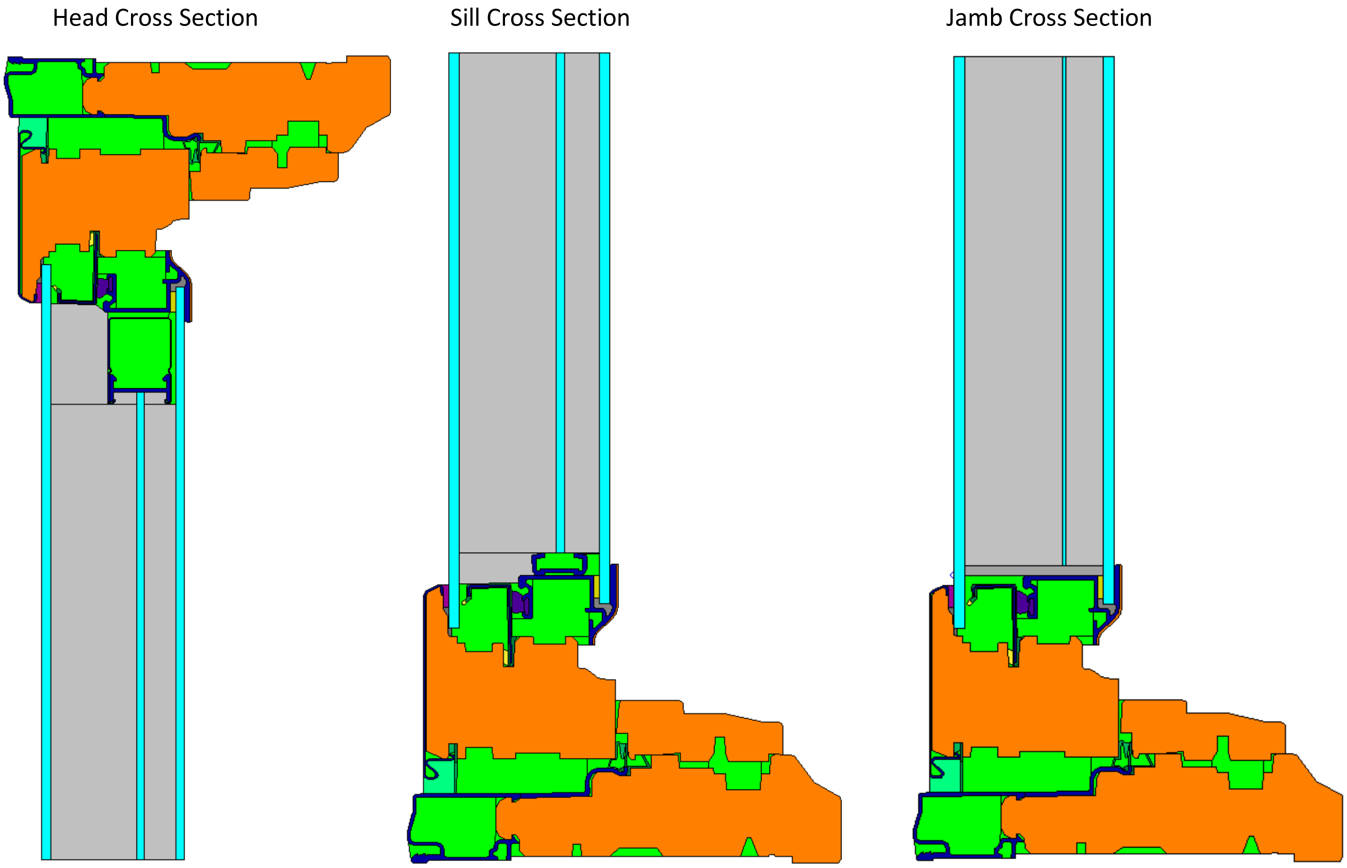


Figure 19-54. Head and Sill cross sections for Closed Venetian Blind between glass layers (Integral)

Boundary Conditions: For Integral Venetian Blinds, set "Shading System Modifier" to "None"

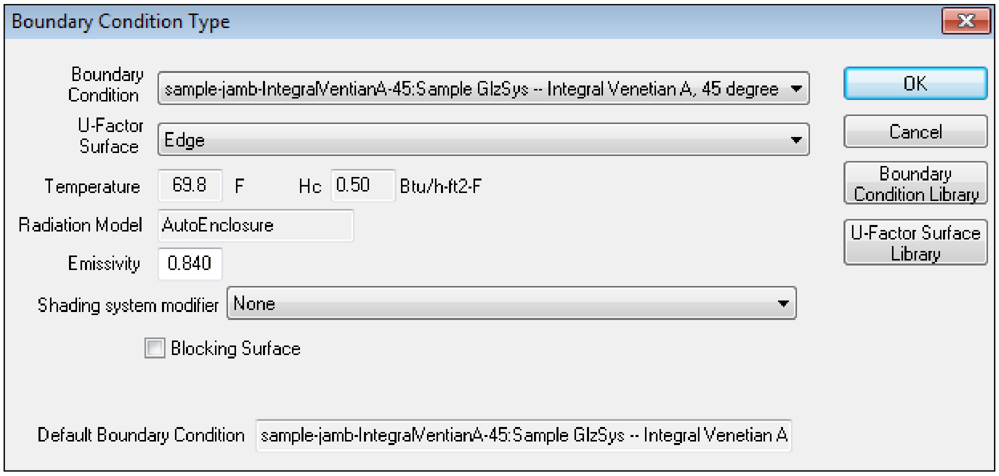


Figure 19-55. For Integral Venetian blinds, set the Shading System Modifier to "None".

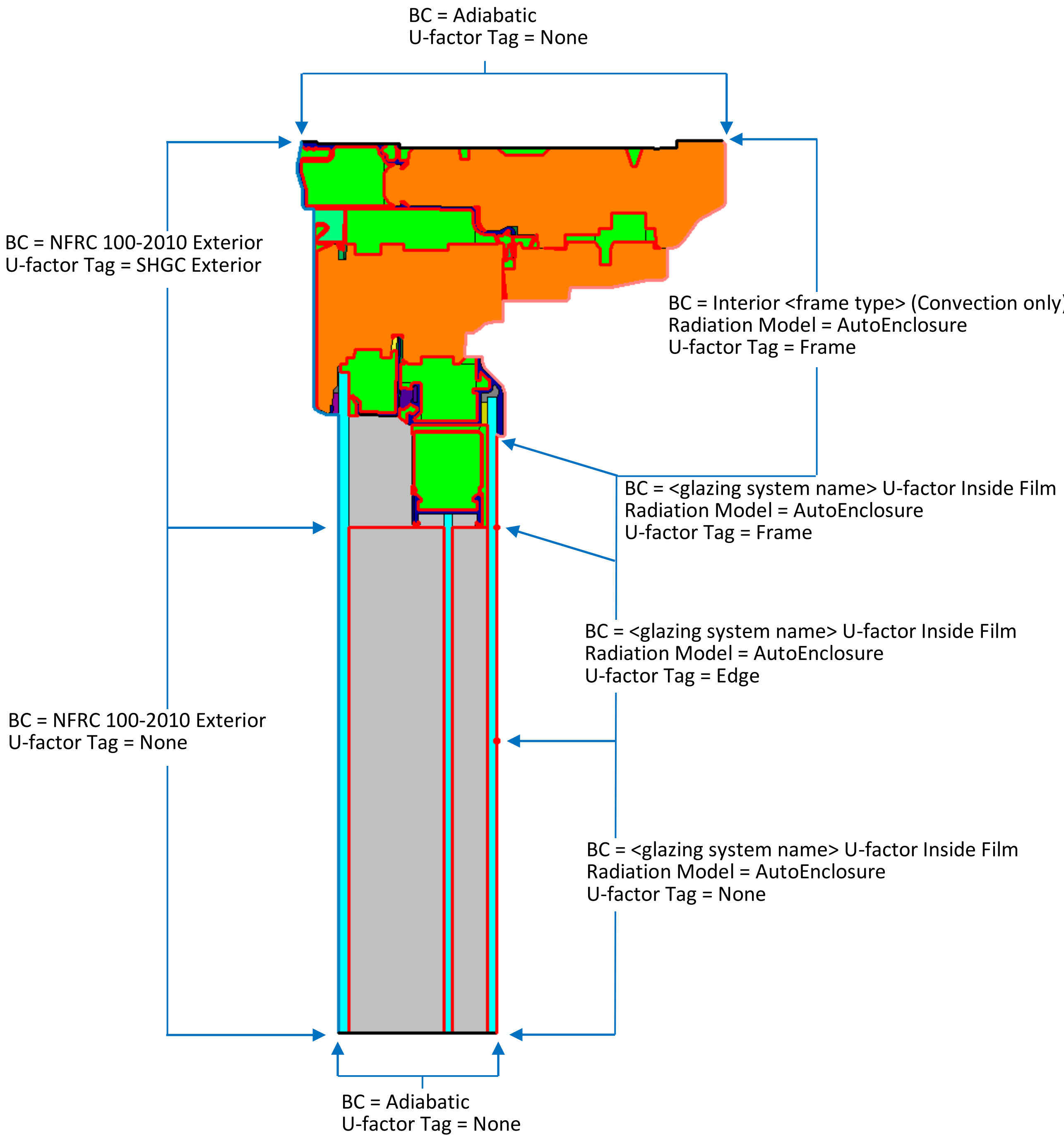


Figure 19-56. Define the boundary conditions for Head Non-Retractable Closed Venetian Blind section

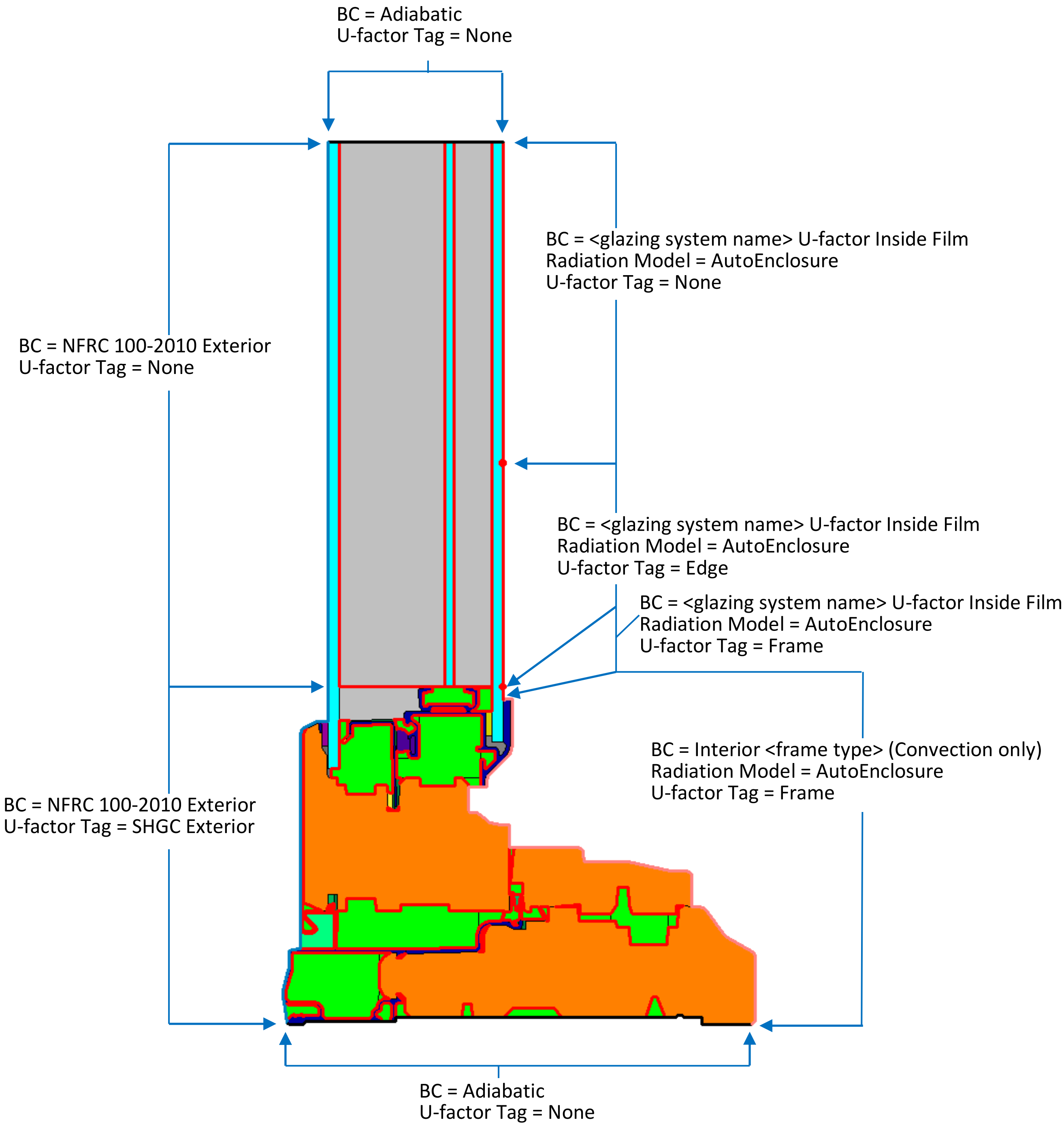


Figure 19-57. Define the boundary conditions for Sill Non-Retractable Closed Venetian Blind section

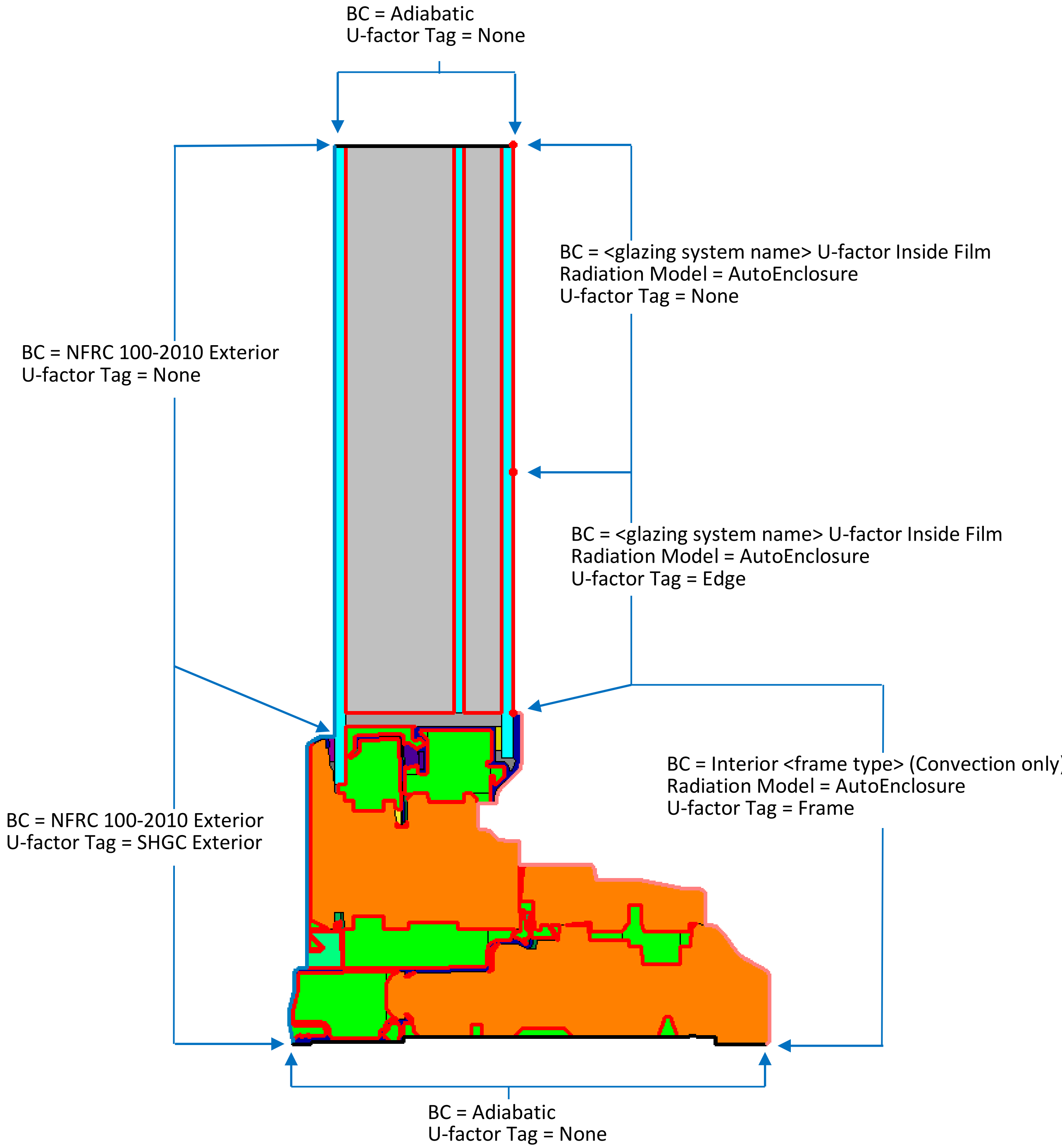
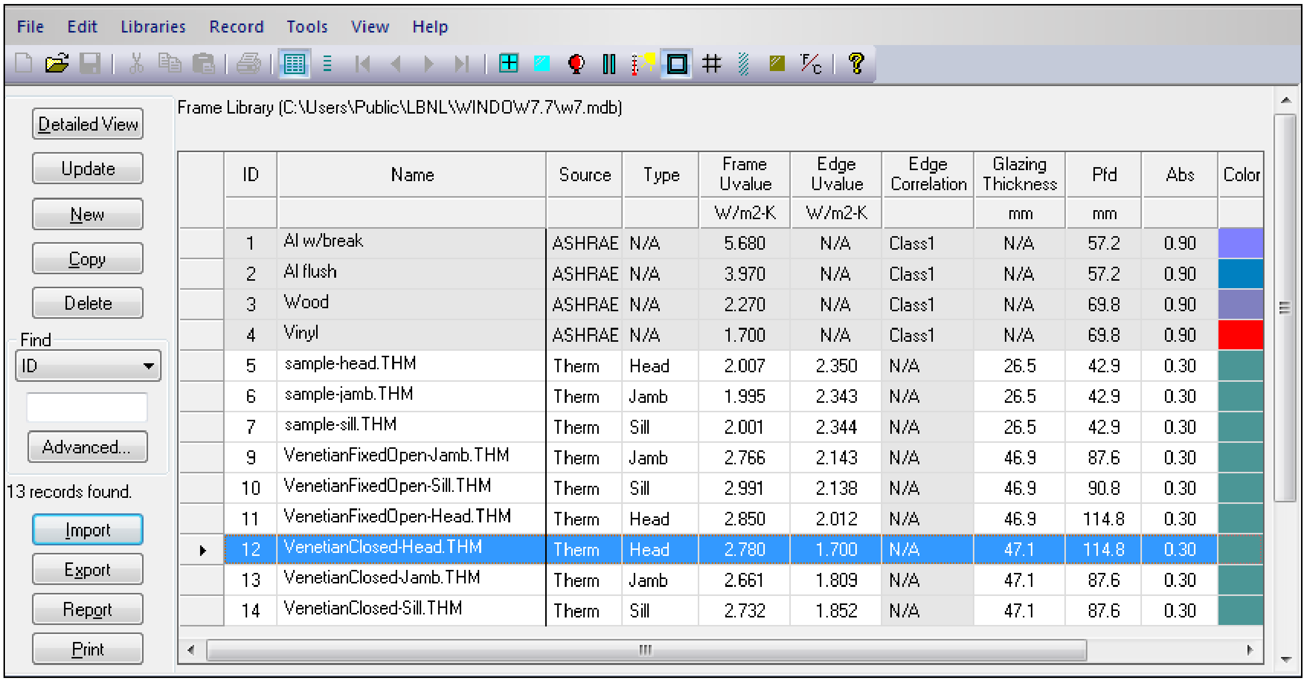


Figure 19-58. Define the boundary conditions for Jamb Non-Retractable Closed Venetian Blind section

Simulate each cross section and save the results

In WINDOW:

1. **Frame Library:** Import the THERM files into the Frame Library



ID	Name	Source	Type	Frame Uvalue	Edge Uvalue	Edge Correlation	Glazing Thickness	Pfd	Abs	Color
				W/m2-K	W/m2-K		mm	mm		
1	Al w/break	ASHRAE	N/A	5.680	N/A	Class1	N/A	57.2	0.90	
2	Al flush	ASHRAE	N/A	3.970	N/A	Class1	N/A	57.2	0.90	
3	Wood	ASHRAE	N/A	2.270	N/A	Class1	N/A	69.8	0.90	
4	Vinyl	ASHRAE	N/A	1.700	N/A	Class1	N/A	69.8	0.90	
5	sample-head.THM	Therm	Head	2.007	2.350	N/A	26.5	42.9	0.30	
6	sample-jamb.THM	Therm	Jamb	1.995	2.343	N/A	26.5	42.9	0.30	
7	sample-sill.THM	Therm	Sill	2.001	2.344	N/A	26.5	42.9	0.30	
9	VenetianFixedOpen-Jamb.THM	Therm	Jamb	2.766	2.143	N/A	46.9	87.6	0.30	
10	VenetianFixedOpen-Sill.THM	Therm	Sill	2.991	2.138	N/A	46.9	90.8	0.30	
11	VenetianFixedOpen-Head.THM	Therm	Head	2.850	2.012	N/A	46.9	114.8	0.30	
12	VenetianClosed-Head.THM	Therm	Head	2.780	1.700	N/A	47.1	114.8	0.30	
13	VenetianClosed-Jamb.THM	Therm	Jamb	2.661	1.809	N/A	47.1	87.6	0.30	
14	VenetianClosed-Sill.THM	Therm	Sill	2.732	1.852	N/A	47.1	87.6	0.30	

Figure 19-59. Import the THERM files into the WINDOW Frame Library

2. **Window Library:** Construct the window using the THERM files in the Frame Library and the glazing system defined in Glazing System Library and calculate the results.

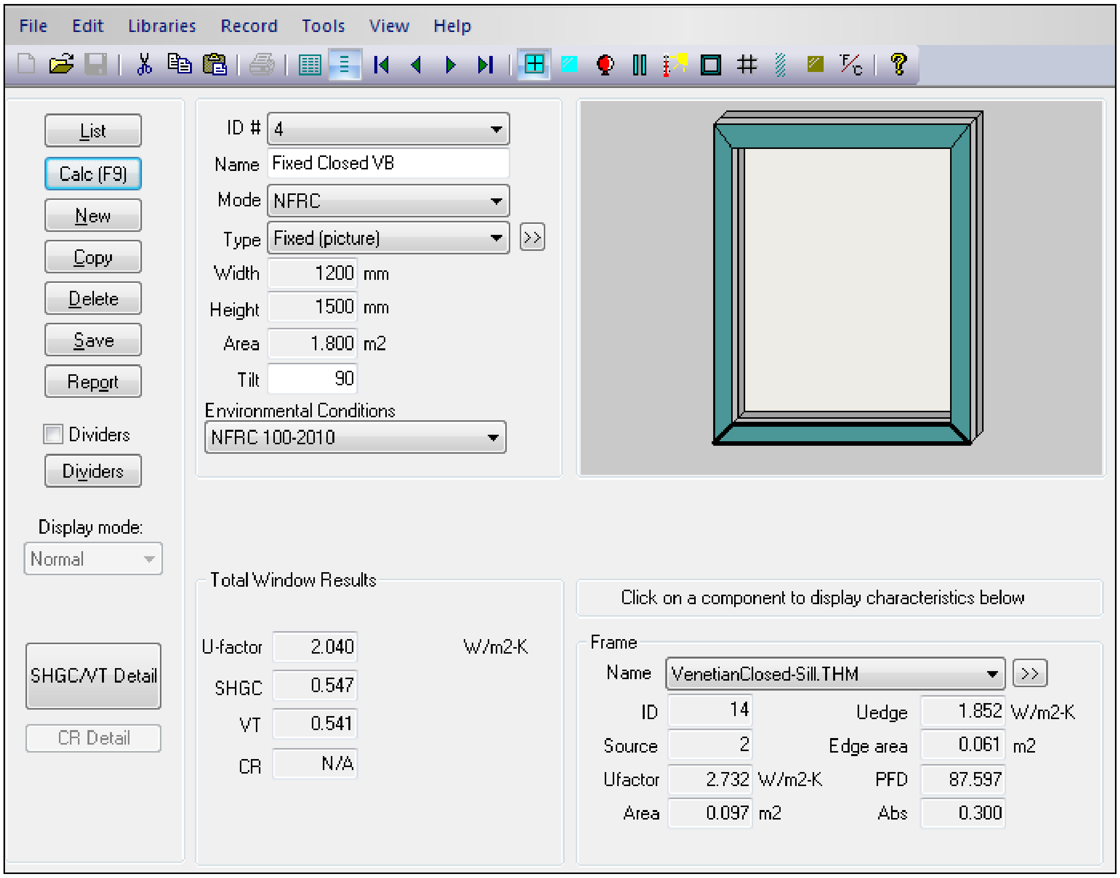


Figure 19-60. Define the window.

19.4 Woven Shades: Outdoor

Outdoor woven shades fall into the category of a dynamic glazing product and can be modeled in both their fully open and fully closed positions in order to fully evaluate their performance. In the case of modeling retractable outdoor woven shades as part of a dynamic glazing product, the fully open position would be the state when the woven shade is completely retracted.

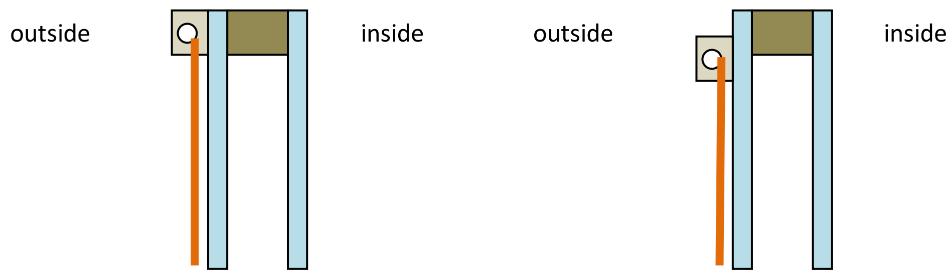


Figure 19-61. Outdoor woven shade is located on the outside of the glazing system. The location of the shading system housing may or may not affect the sight line of the frame.

The following cases must be modeled for each outdoor woven shade configuration:

- **OPEN** – Woven shade in it's most transmitting state
- **CLOSED** – Woven shade in it's least transmitting state

19.4.1. Open Woven Shade

There is one scenario for Open woven shades:

- **Retractable / Open:** Woven Shades that retracts up into an enclosure on the exterior of the frame.

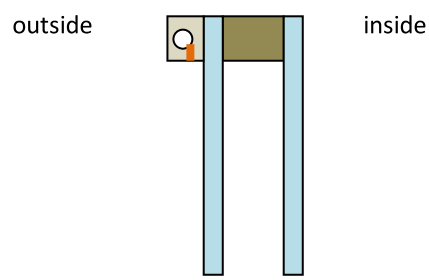


Figure 19-62. Retractable / Open Woven Shade

For **Retractable / Open** woven shades, one example will be illustrated:

- o A woven shade fully retracted with a double glazed system.

19.4.1.1. Fully Retracted / Open Woven Shade With a Double Glazed System

The following section discusses how to model a fully retracted woven shade that has a housing at the top of the woven shade that holds the rolled up shading material on a roller. Figure 19-64 shows the Head cross section for a woven shade in the fully-retracted position with a double-glazed system.

In this example, only the Head section will be shown. All other cross sections (Jambs, Sills and Meeting Stiles) are modeled normally, without any woven shade considerations.

In WINDOW:

1. **Glazing System Library:** Create the appropriate glazing system in the Glazing System Library. In this case, it is not necessary to model a woven shade in WINDOW, because the shade is fully retracted.

In THERM

2. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
3. **Glazing System:** Import the glazing system defined in WINDOW (no woven shade modeling needed) into the frame geometry. Make sure that the Sight line to bottom of glass value includes the height of the block representing the closed woven shade, so that the Frame and Edge of Glass boundary conditions and U-factor tags are defined automatically by THERM.
4. **Boundary Conditions:** Define the Boundary Conditions in the normal manner; no woven shade was modeled in WINDOW, so the Boundary Conditions in THERM do not need to be modified for a Shading System

Detailed Modeling Steps:

The following steps explain in detail how to create the Outdoor Woven Shade model.

In WINDOW:

1. **Glazing System Library:** Define the glazing system and add the outdoor woven shade defined in the Shading Layer Library, in this example record 19, "Woven shade Gray, 25% open area" from the CGDB.

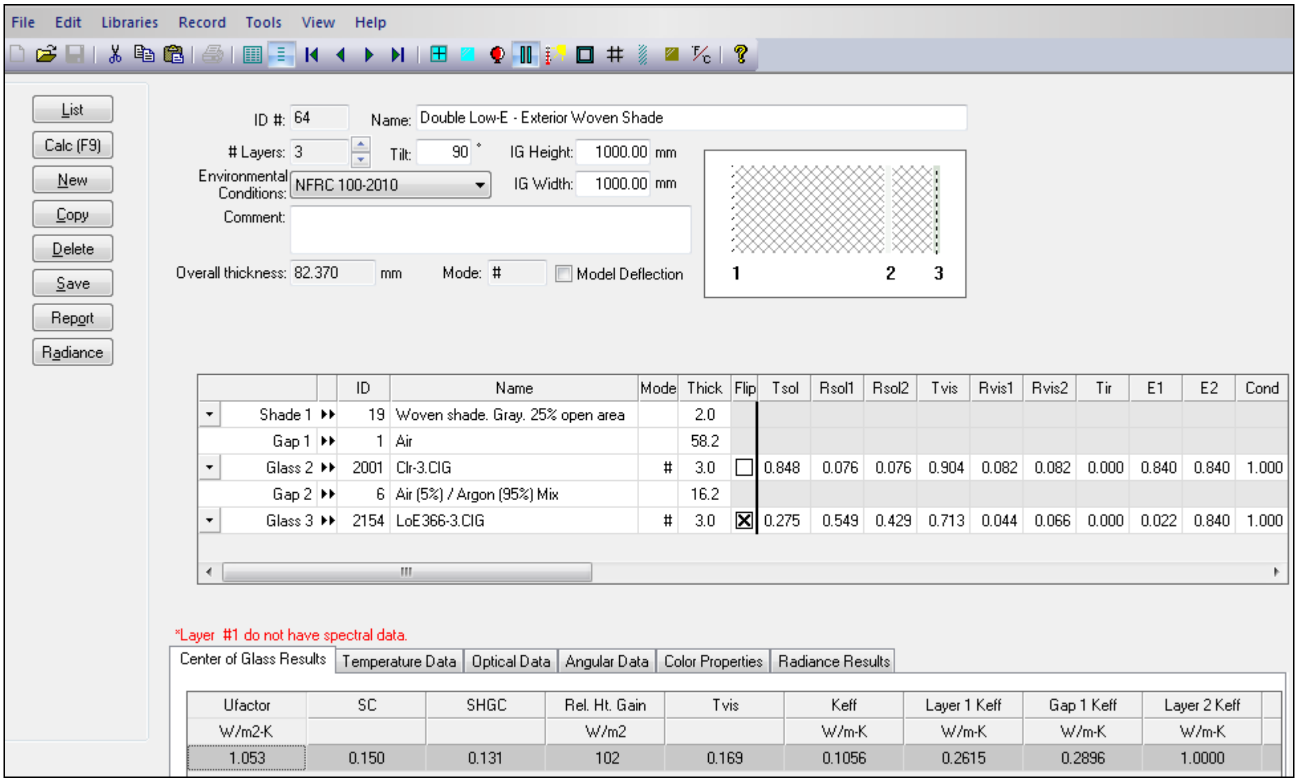


Figure 19-63. Construct the glazing system, adding the shading system as Layer 1, which is the outermost layer.

In THERM:

2. Draw the Head cross section of the product frame. In this example, only the Head cross section needs to be drawn for the "Open" case, because the jambs and sill are the same as if there was not a shading system.
3. Draw the geometry of the housing for the woven shade, and the rolled up woven shade itself inside the housing if applicable. Model the hardware inside the housing according to the guidelines in the Shading System Modeling Overview section earlier in this manual.
4. Insert the glazing system.

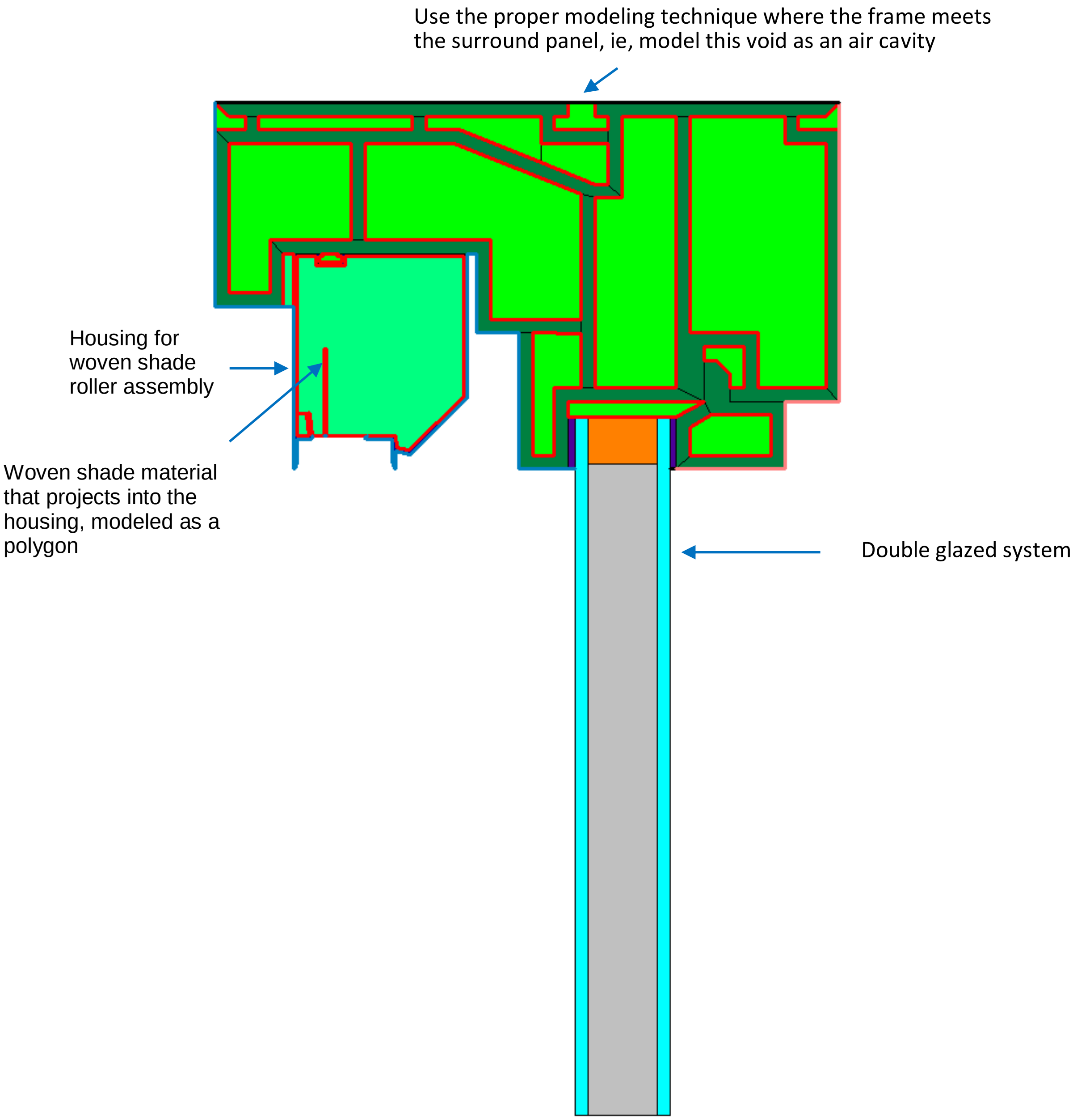


Figure 19-64. Head cross section with fully retracted woven shade with a double-glazed system.

5. Generate the Boundary Conditions.

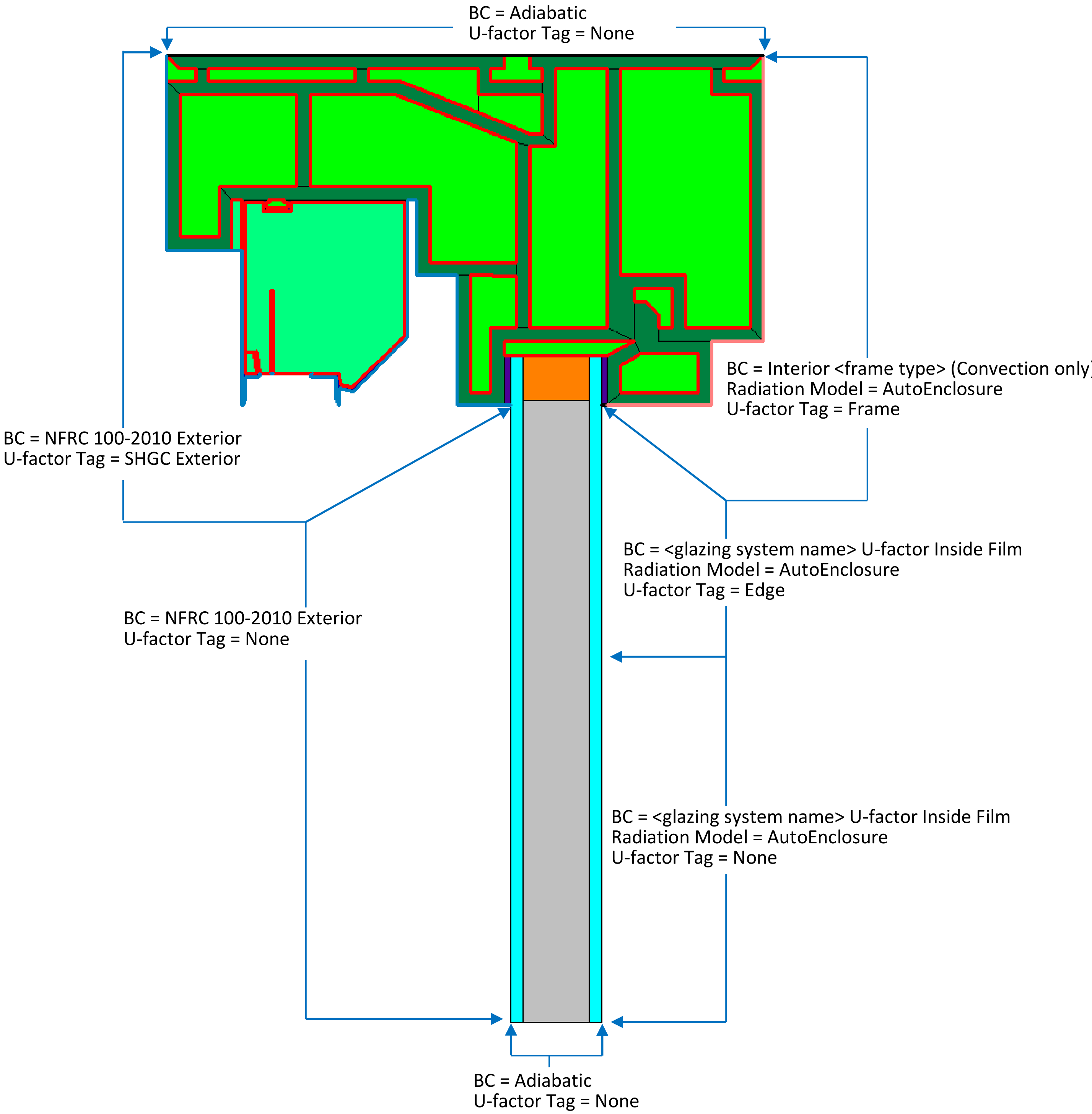


Figure 19-65 Define the boundary conditions for the cross section

6. Calculate the results for this cross section.
7. Complete the calculations for the other product cross sections (Sill, Jambs and Meeting Rails / Stiles as appropriate).
8. Import all the cross sections into the WINDOW Frame Library

Calculate the total product U-value, SHGC and VT in the Window Library.

19.4.2. Closed Exterior Woven Shade

According to NFRC 100 and 200, dynamic glazing products must be rated in both their fully open and fully closed positions. This section describes modeling an Exterior Woven Shade in the closed position.

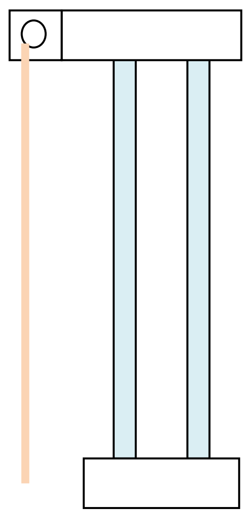


Figure 19-66. A closed Exterior Woven Shade.

In WINDOW:

1. **Shade Material Library:** Make sure that the appropriate material is in the Shade Material Library. If it is not, contact the manufacturer to submit data to the CGDB. For this example, we are using the generic woven shade material called “Generic Woven Shade Material”.
2. **Shading Layer Library:** Reference the “Generic Woven Shade” material and define the Woven Shade thread geometry in the Shading Layer Library
3. **Glazing System Library:** Define the glazing system with the closed woven shade on the exterior side of the glazing system.

In THERM:

4. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
5. **Glazing System:** Import the glazing system defined with the woven shade into the frame geometry
6. **Boundary Conditions:** For Exterior Woven Shades, set “Shading System Modifier” to “Exterior (Glazing System ID: <nn>)”
7. Simulate the model, save the results

In WINDOW:

8. **Frame Library:** Import the THERM files into the Frame Library
9. **Window Library:** Construct the window using the THERM files in the Frame Library and the glazing system defined in Glazing System Library

These steps are illustrated in more detail in the following discussion.

In WINDOW:

1. **Glazing System Library:** Define the glazing system with the appropriate woven shade layer on the outside of the glazing system. See Shading System Overview section for detailed instructions for adding shading systems to glazing systems.
2. Set **Dtop**, **Dbot**, **Dright**, **Dleft** to the appropriate values for the woven shade.

In THERM:

1. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate. In this example, the hardware for the woven shade is only drawn for the Head cross section. The hardware on the bottom of the shade for the Sill is part of the shade layer and is not drawn.

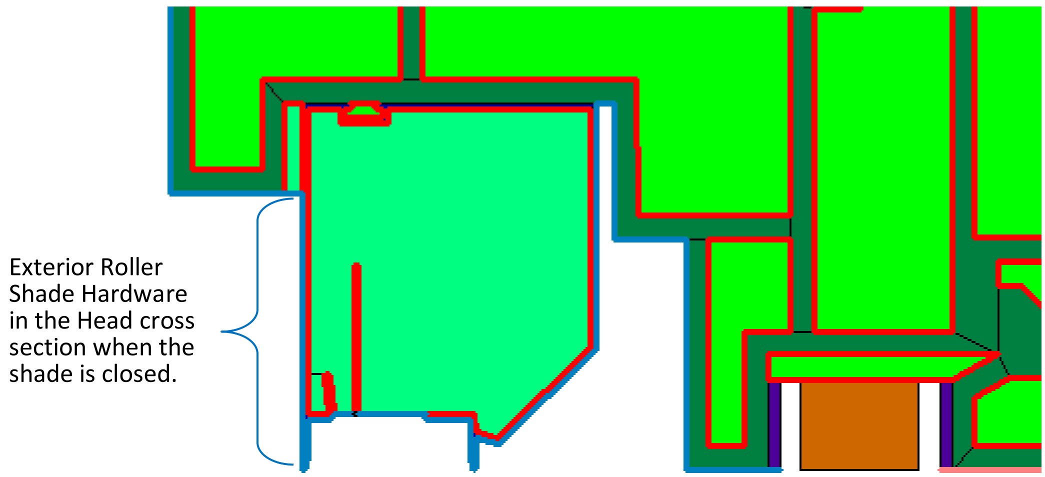


Figure 19-67. Draw the frame with the exterior woven shade continuous hardware, in this case for the Head cross section.

2. **Glazing System:** Import the glazing system defined with the woven shade into the frame geometry. The important input value for shading layers is the "Sight line to shade edge" value. In the Head cross section example below, the edge of the shade (at the bottom of the hardware) starts above the sight line, so the "Sight line to shade edge" value in this case is negative.

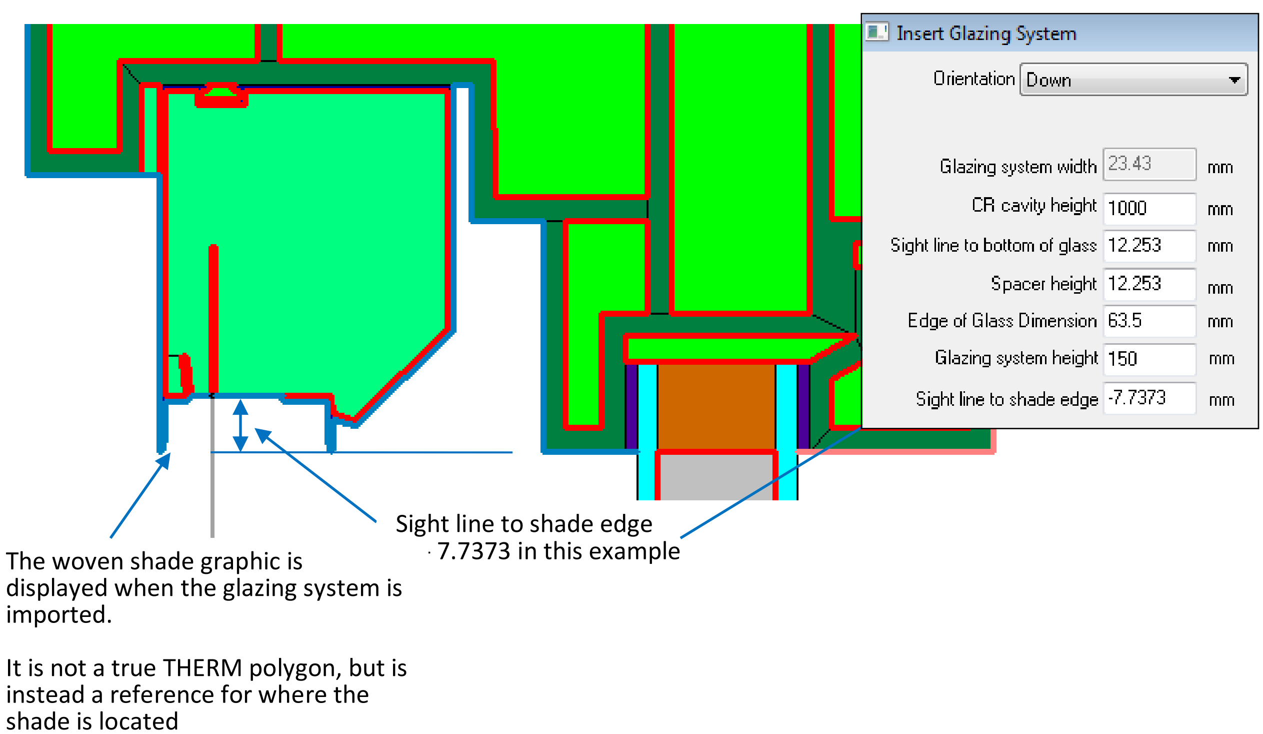


Figure 19-68. Insert the glazing system with the Exterior Roller Shade into the Head cross section.

For the Sill and Jamb cross sections in this example, the woven shade extends below the sight line of the frame, so the "Slight line to shade edge" value is actually negative.

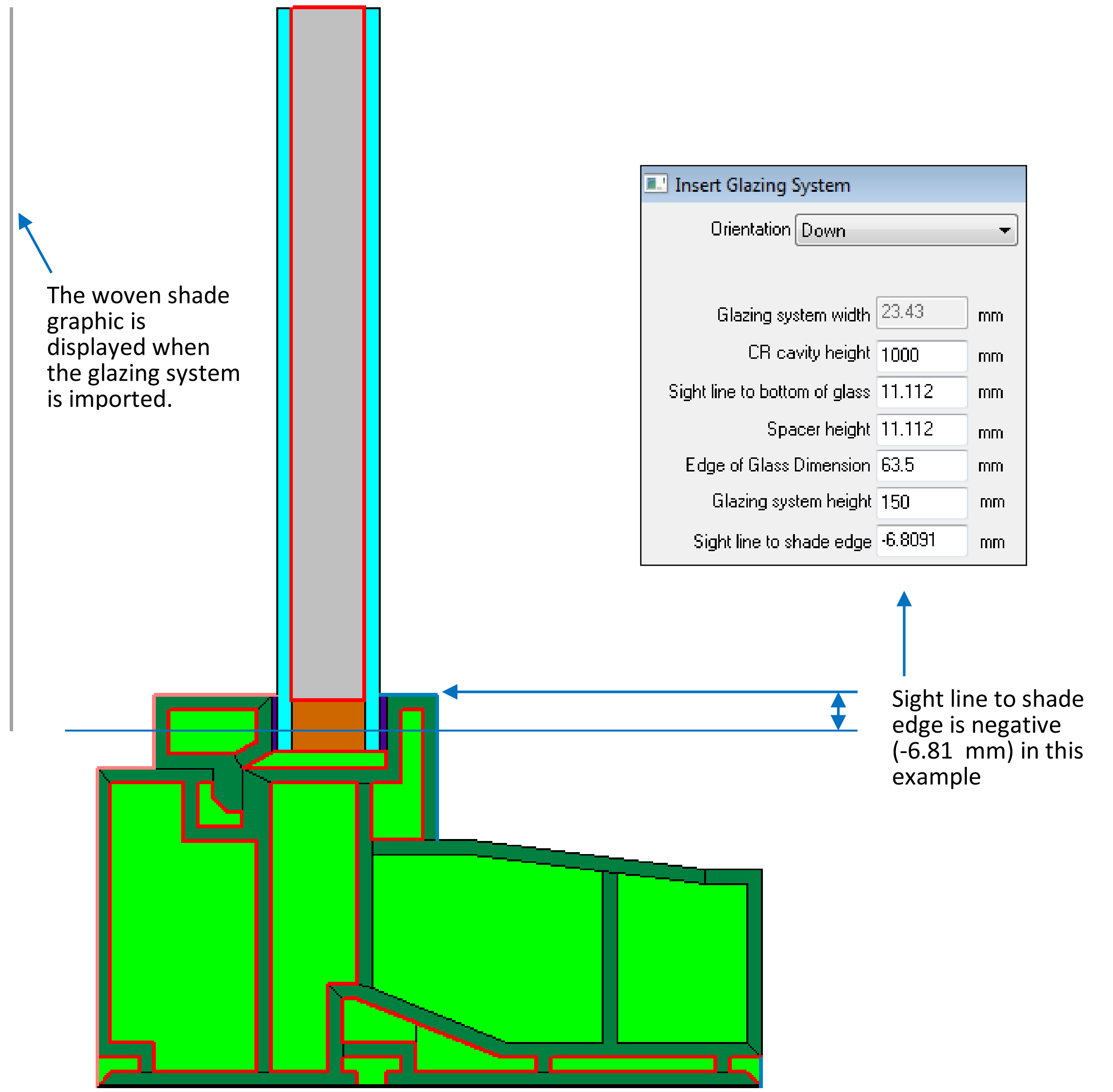


Figure 19-69. Insert the glazing system with the Exterior Roller Shade into the Sill and Jamb cross sections.

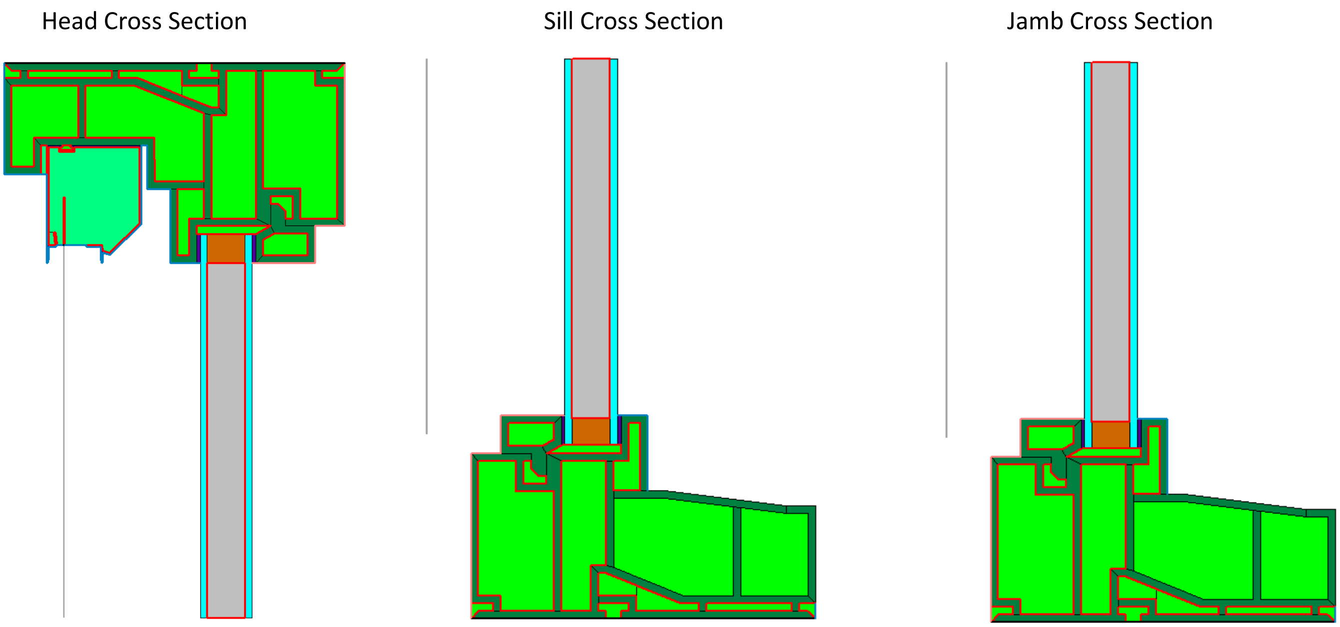


Figure 19-70. Head, Sill and Jamb cross sections for Closed Roller Shade on the exteropr of a glazing system

3. **Boundary Conditions:** For Outdoor Woven Shades, set "Shading System Modifier" to "Exterior (Glazing System ID: <nn>)" for the exterior boundary condition (NFRC 100-2010 Exterior) where the shade projects onto either the glazing system or the frame.

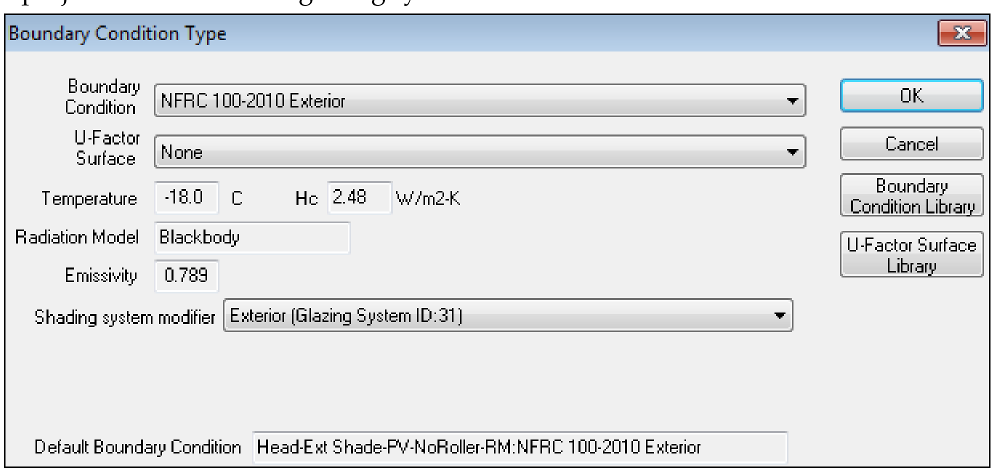


Figure 19-71. For Outdoor Woven Shades, set the Shading System Modifier to "Exterior (Glazing System ID: <nn>)" where appropriate on the glazing system and frame.

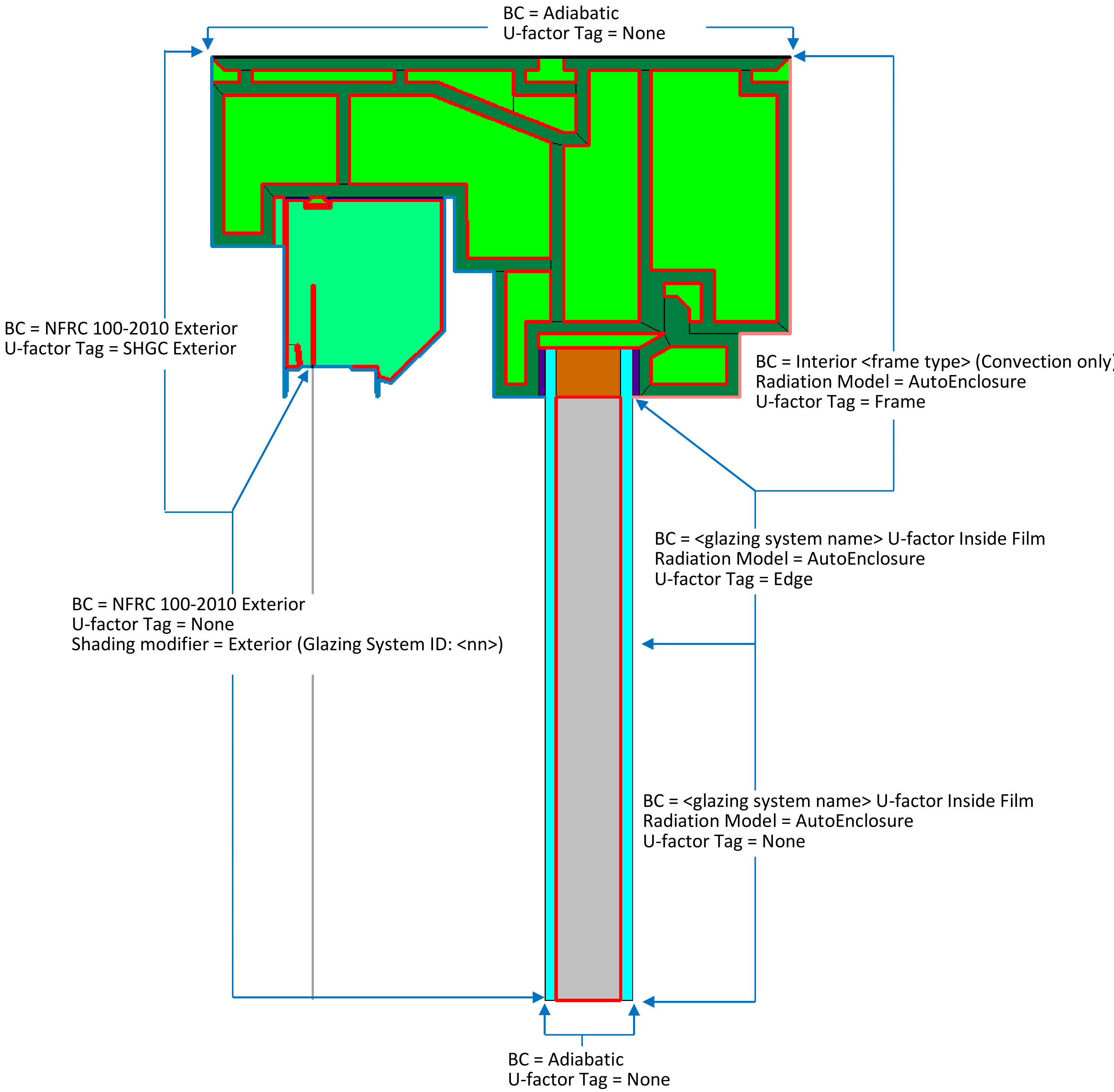


Figure 19-72. Define the boundary conditions for the Head cross section

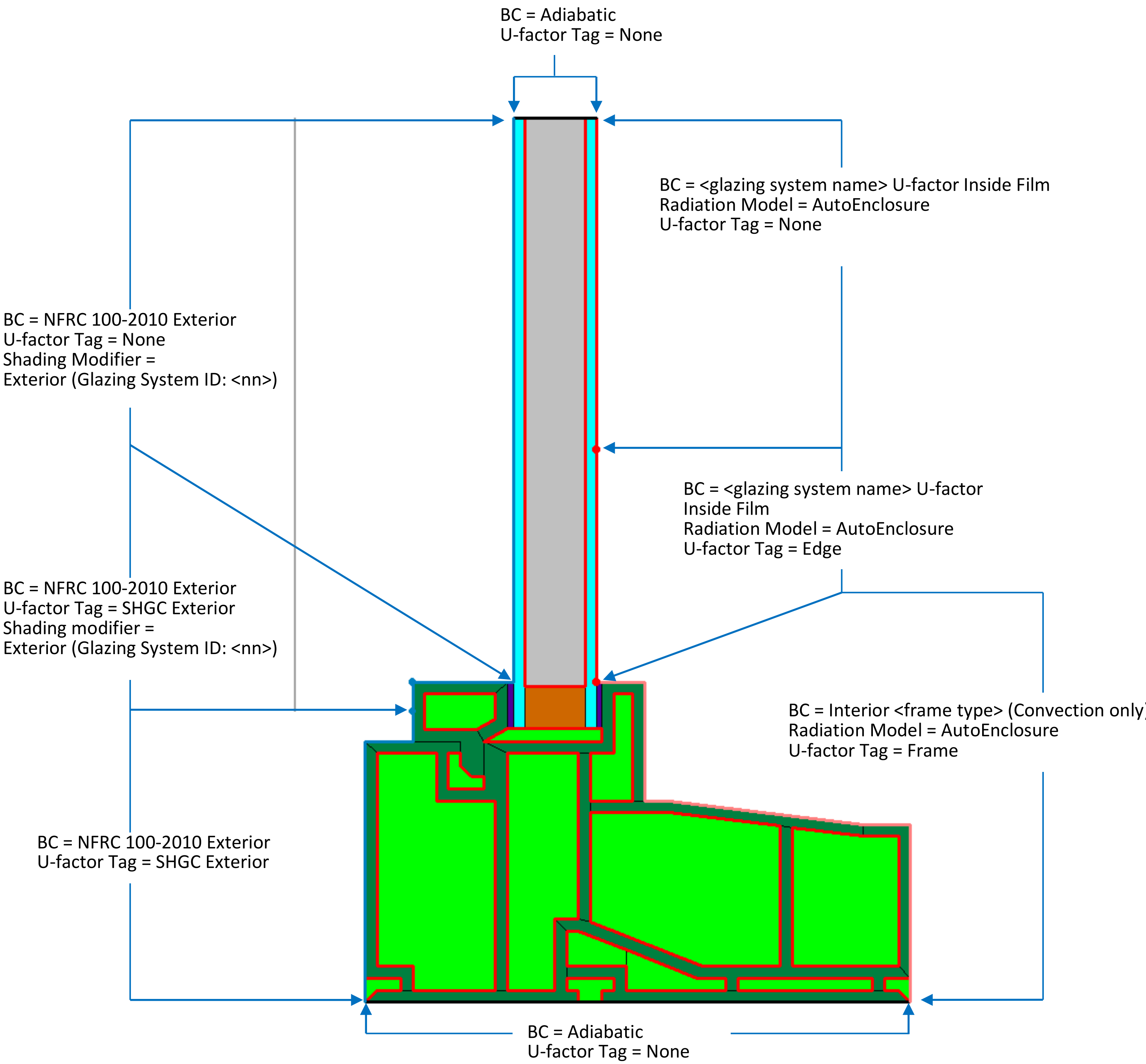
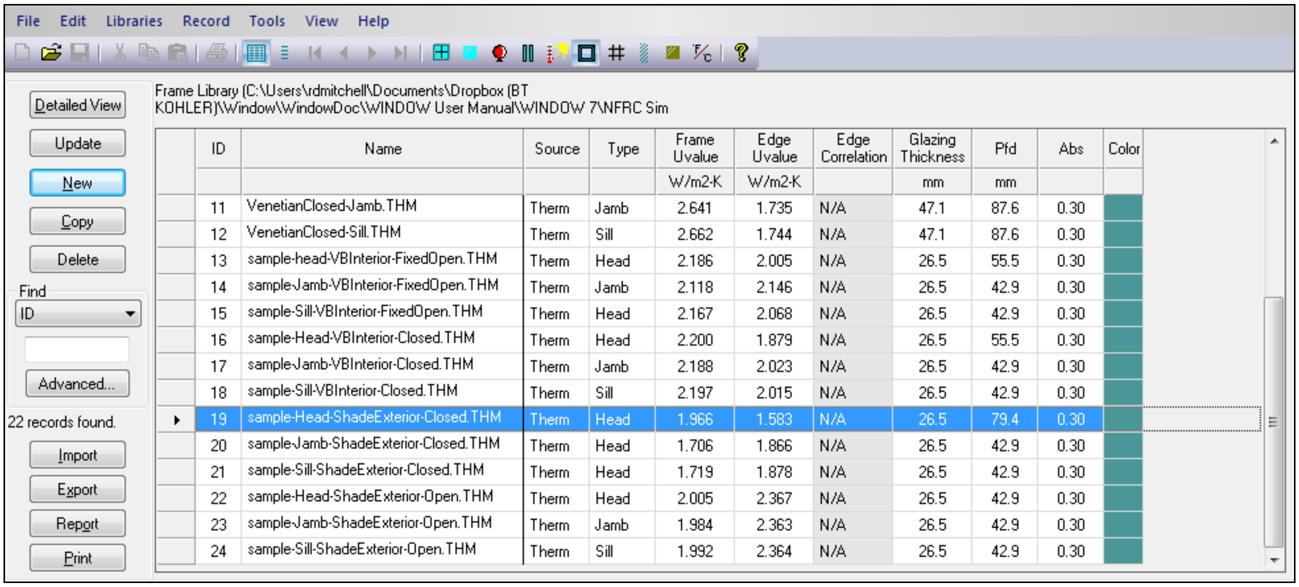


Figure 19-73. Define the boundary conditions for the Jamb and Sill cross section.

4. Simulate each cross section and save the results

In WINDOW:

5. **Frame Library:** Import the THERM files into the Frame Library



ID	Name	Source	Type	Frame Uvalue W/m2-K	Edge Uvalue W/m2-K	Edge Correlation	Glazing Thickness mm	Pfd mm	Abs	Color
11	VenetianClosed-Jamb.THM	Therm	Jamb	2.641	1.735	N/A	47.1	87.6	0.30	
12	VenetianClosed-Sill.THM	Therm	Sill	2.662	1.744	N/A	47.1	87.6	0.30	
13	sample-head-VBInterior-FixedOpen.THM	Therm	Head	2.186	2.005	N/A	26.5	55.5	0.30	
14	sample-Jamb-VBInterior-FixedOpen.THM	Therm	Jamb	2.118	2.146	N/A	26.5	42.9	0.30	
15	sample-Sill-VBInterior-FixedOpen.THM	Therm	Head	2.167	2.068	N/A	26.5	42.9	0.30	
16	sample-Head-VBInterior-Closed.THM	Therm	Head	2.200	1.879	N/A	26.5	55.5	0.30	
17	sample-Jamb-VBInterior-Closed.THM	Therm	Jamb	2.188	2.023	N/A	26.5	42.9	0.30	
18	sample-Sill-VBInterior-Closed.THM	Therm	Sill	2.197	2.015	N/A	26.5	42.9	0.30	
19	sample-Head-ShadeExterior-Closed.THM	Therm	Head	1.966	1.583	N/A	26.5	79.4	0.30	
20	sample-Jamb-ShadeExterior-Closed.THM	Therm	Head	1.706	1.866	N/A	26.5	42.9	0.30	
21	sample-Sill-ShadeExterior-Closed.THM	Therm	Head	1.719	1.878	N/A	26.5	42.9	0.30	
22	sample-Head-ShadeExterior-Open.THM	Therm	Head	2.005	2.367	N/A	26.5	42.9	0.30	
23	sample-Jamb-ShadeExterior-Open.THM	Therm	Jamb	1.984	2.363	N/A	26.5	42.9	0.30	
24	sample-Sill-ShadeExterior-Open.THM	Therm	Sill	1.992	2.364	N/A	26.5	42.9	0.30	

Figure 19-74. Import the THERM files into the WINDOW Frame Library

6. **Window Library:** Construct the window using the THERM files in the Frame Library and the glazing system defined in Glazing System Library and calculate the results.

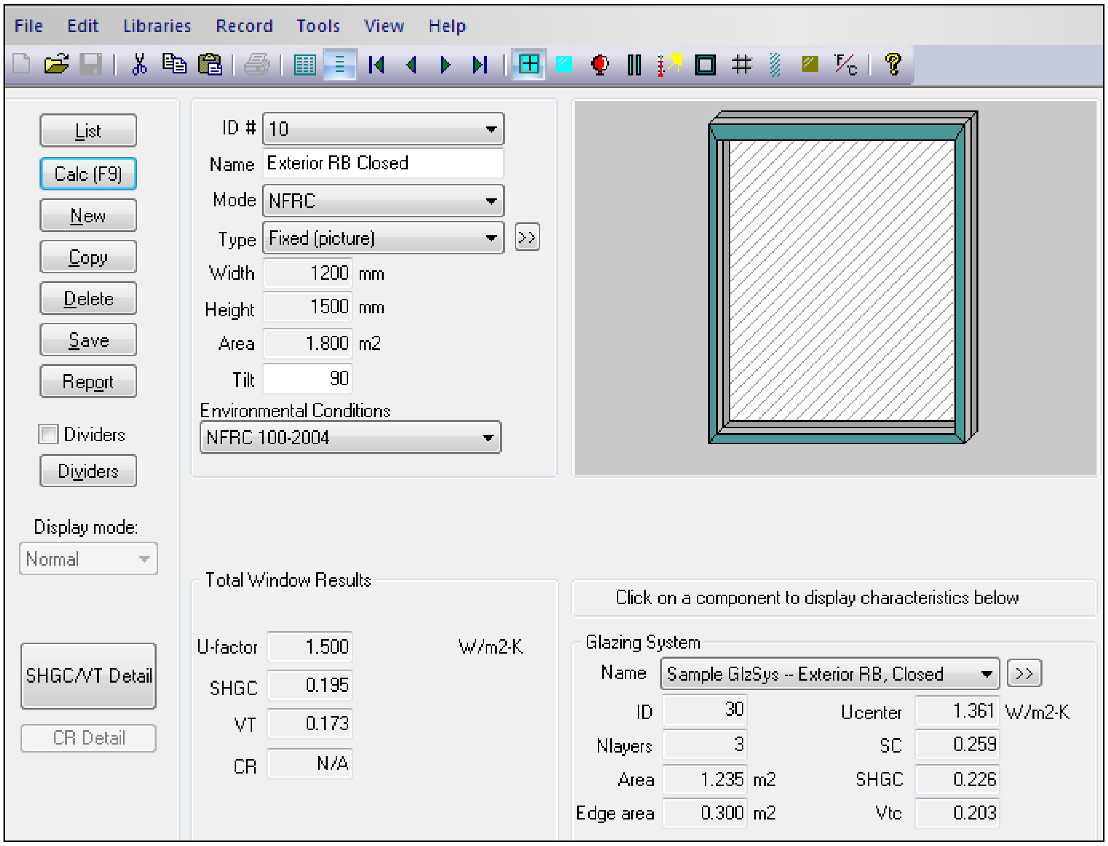


Figure 19-75. Define the window.

19.5. Insulating Shade Layers with Non-Standard Geometry

THERM can be used to define the geometry and material properties for shading systems that are not otherwise easily characterized in WINDOW. This modeling method can be applied to:

- Cellular Shades
- Pleated Shades
- Roman Shades
- Roller Shutters
- Window Quilts
- Other shades with a complicated or mult-component geometry

This section will deal explicitly with how to model cellular shades and roller shutters. However, the methodology presented here can be used for other shading systems as well.

The modeling steps are as follows:

- In WINDOW:
    - Define the materials used for the shading layer in the Shade Material Library by either adding it directly or importing a record from the CGDB or the Optics User Database.
        - The optical properties of materials used to define the outer surfaces of the THERM model should be measured in a spectrophotometer, even if they are opaque, in order for Radiance to model the correct reflectance of the surface based on the geometry
- In THERM
    - In Radiance Mode, import the materials from the WINDOW Shade Material Library
    - In Radiance Mode, draw the geometry of the shading layer in THERM
    - Assign the materials defined in WINDOW to the geometry drawn in THERM
    - Assign special boundary conditions, including both the “front” and the “back” of each material
        - Assign the outside boundary conditions as Illuminated Surfaces where required
- In WINDOW:
    - Define the Shading System in the WINDOW Shading Layer Library, set the Type to “Therm File (*.thmx)”, and reference the THERM file in the BSDF file input box.
    - Enter the Permeability Factor (thermal) and Perforation Ratio (optical) of the Shading Layer.
    - Calculate the Shading Layer and then use it in a glazing system and whole window.
        - THERM will run Radiance in the background to generate a “genBSDF” XML file with optical properties based on the materials and geometry of the THERM file

19.5.1. WINDOW: Define Shade Layer Library Materials

The materials that will be used for the shading layer drawn in THERM are first defined in WINDOW, and then referenced from THERM.

The Shading Layer Materials that can be defined in WINDOW to be used to model the shading layer in THERM can be transmitting or opaque, and spectral or non-spectral.

These materials must be added to the WINDOW Shade Material Library, so that they can then be imported into the THERM Material library and used in the shading layer THERM model.

Records can be added to the WINDOW Shade Material Library either by directly making a new record in the library and entering the average spectral data values "by hand", or by importing a record from the CGDB or the Optics User Database (data measured in a spectrophotometer can be imported into Optics and then imported into the WINDOW Shade Material Library). See the WINDOW User Manual section on the Shade Material Library for details about adding records to that library.

Either approach results in records in the WINDOW Shade Material Library that can be assigned to the polygons in THERM that represent, for example, the cell walls in a cellular shade.

Shade Material Library (C:\Users\Public\LBNL\WINDOW7.7\w7.mdb)

ID	Name	ProductName	Manufacturer	Source
31033	C23_innerwalls.txt	C23 White/Alumium back	Hunter Douglas	CGDB
31034	C22-951_innerwalls.txt	C22-951 Inner wall	Hunter Douglas	CGDB
31035	C22-951_outerwalls.txt	C22-951 Outer wall	Hunter Douglas	CGDB
31036	C22-951_glueline.txt	C22-951 Glue line	Hunter Douglas	CGDB
31037	C82_TransparentPlastic.txt	C82 Transparent plastic	Hunter Douglas	CGDB
31038	D2_WhiteWallMaterial.txt	D2 White wall	Hunter Douglas	CGDB
31039	D7_WhiteOnSilverBack.txt	D7 White on Silver back	Hunter Douglas	CGDB
31040	D8_WhiteSheer.txt	D8 - White sheer	Hunter Douglas	CGDB

Figure 19-76. The example materials above in the WINDOW Shade Material Library are used to define cellular shade surfaces in THERM

19.5.2. THERM: Therm Preference Settings

In THERM, in the **Options** menu, **Preferences** tab, set the following options:

- **Automatic XML Export on Save** = Checked
  - This will cause THERM to automatically write out the <filename>.thmx XML format file, which WINDOW will use for the Radiance simulation to calculate the optical properties based on the THERM model.

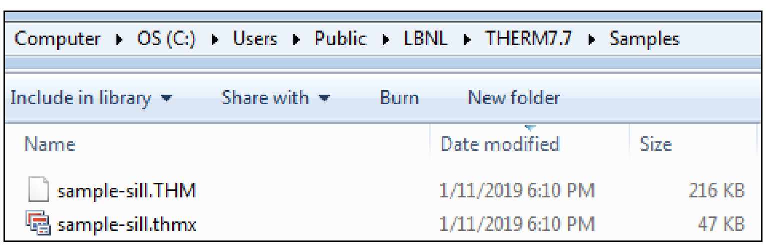


Figure 19-77. THERM automatically creates the <filename>.thmx file when "Automaticl XML Export on Save" is checked in the Preferences tab

- **Radiance Mode** = Checked
  - The THERM file background color is gray when Radiance mode is checked.
  - Radiance mode must be unchecked for standard THERM calculations, so make sure to uncheck when not modeling non-standard geometry insulating shade layers such as cellular shades, pleated shades or roller shutters.

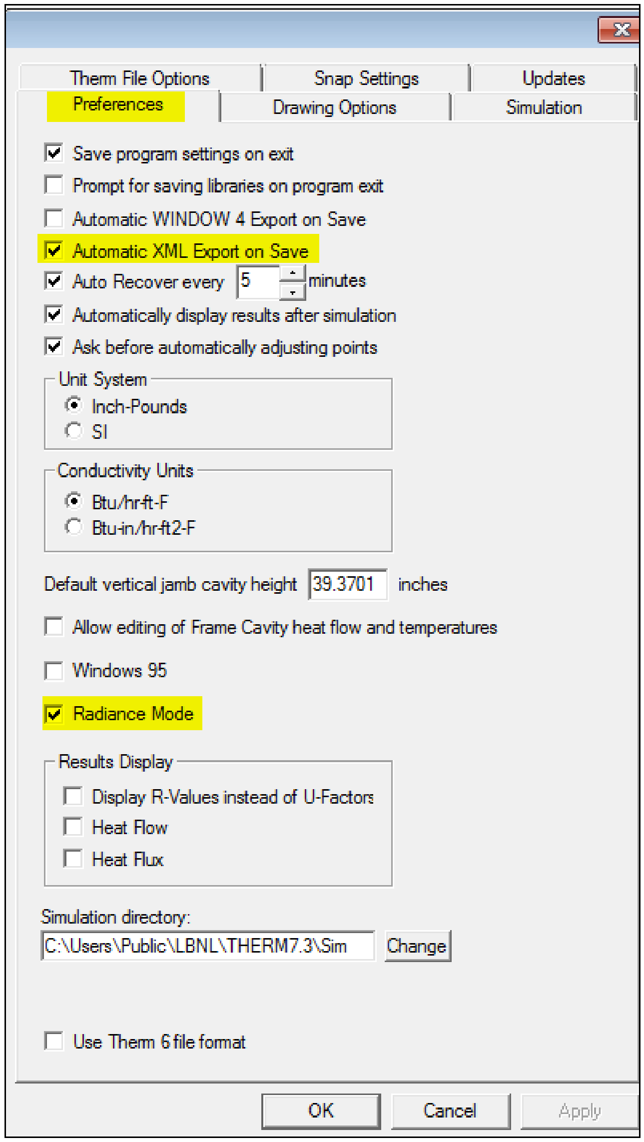


Figure 19-78. THERM Options / Preferences

19.5.3. THERM: Add the WINDOW Shade Materials to the THERM Material Library

Once the appropriate materials have been defined in the WINDOW Shade Material Library, they need to be added to the THERM Material Library.

From the **Library** menu in THERM, select the **Material Library** option, which will open the **Material Definition** dialog box.

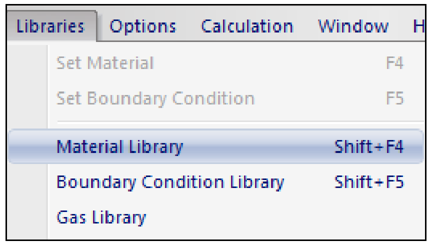


Figure 19-79. In THERM, select the Libraries / Material Library option to add the WINDOW Shade Materials to the THERM Material Library

In the **Material Definitions** dialog box, click the **Load Shade Material** button to add a Shade Material record from WINDOW to be used to define the material properties in THERM.

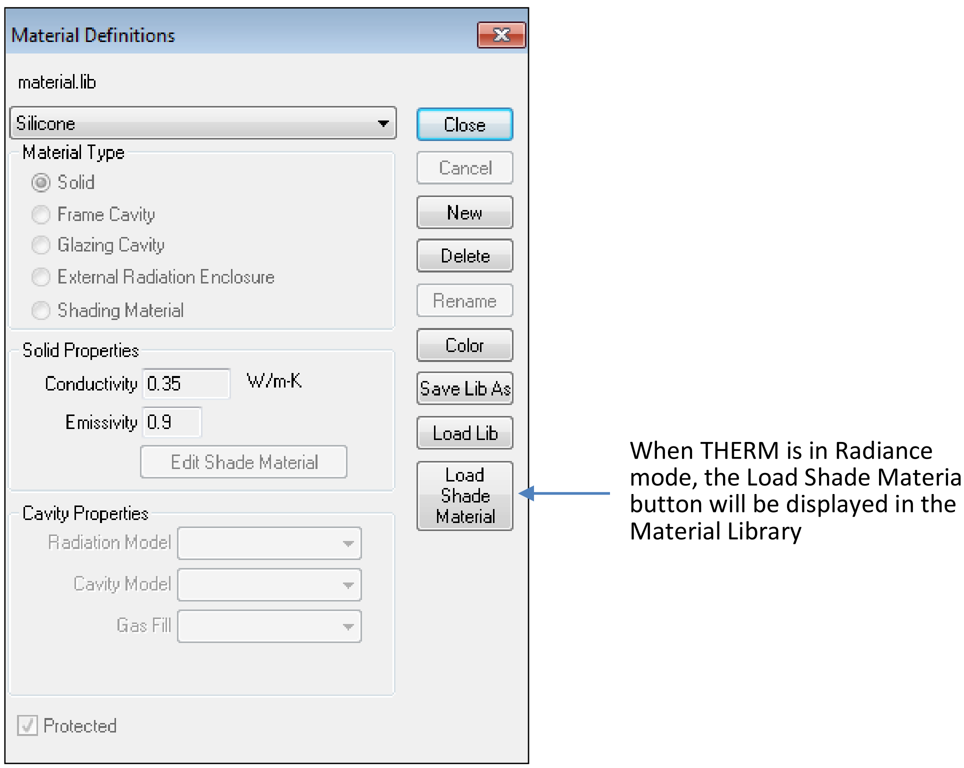


Figure 19-80. Click on the Load Shade Material button to add a WINDOW Shade Material to the THERM Material Library (make sure THERM is in "Radiance" mode)

The THERM Shade Materials dialog box will appear. The WINDOW Database section allows browsing to the appropriate WINDOW database file where the shade materials have been defined. The Shade Material pulldown list will show all the records in the WINDOW Shade Material Library. The optical and thermal properties from the WINDOW Shade Material will be displayed below the Shade Material pulldown list.

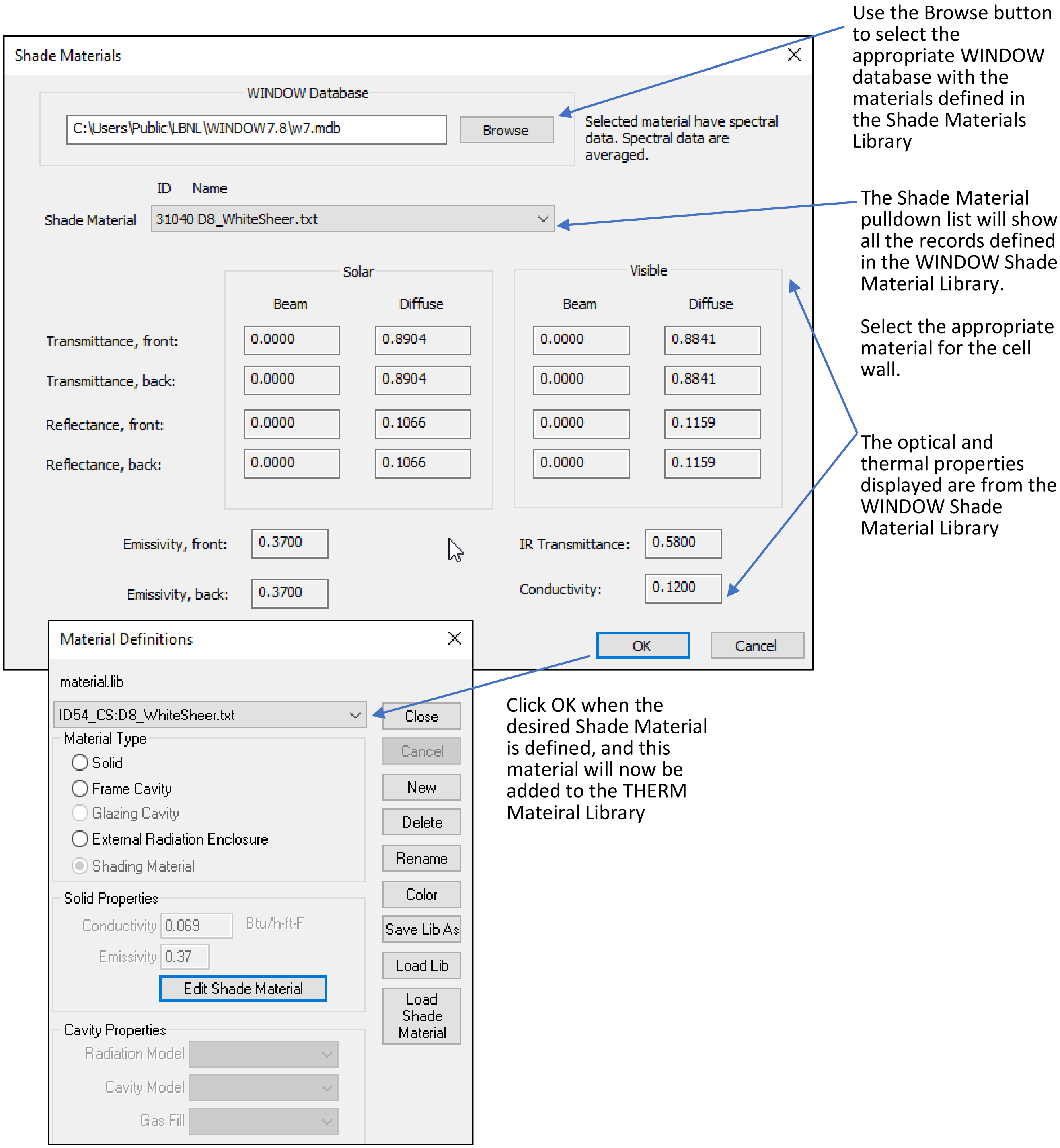


Figure 19-81. The THERM Shade Materials dialog box allows browsing the WINDOW database and selecting a Shade Material from that database.

19.5.4. THERM: Define Shade Geometry Component in THERM

The next step is to define the geometry of the shade layer in THERM. If there are repeating components in the shading system, create one component and make sure that it will calculate before making a series of components.

The sections following this general discussion contain examples for cellular shades and roller shutters, and provide the details for creating these models.

19.5.5. THERM: Generate Boundary conditions

Generate the boundary conditions for the model

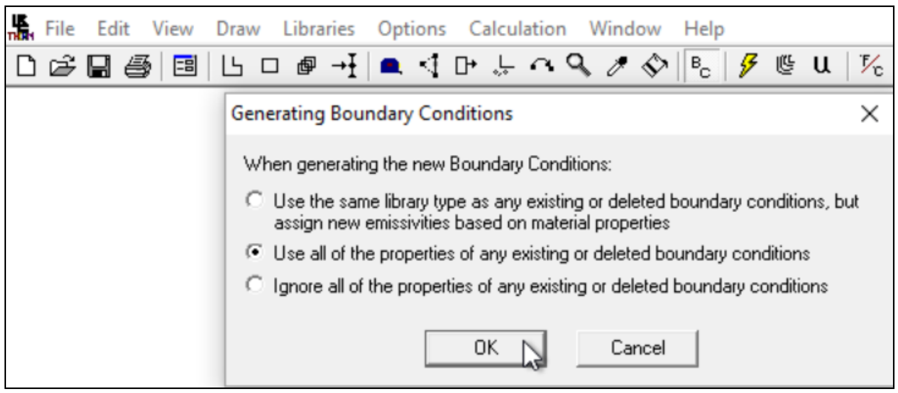


Figure 19-82. Generate the Boundary Conditions

For THERM models that will be imported into WINDOW for modeling shading systems, there are special rules for the boundary condition definitions.

The emissivity associated with a boundary condition is static to the material that was present when creating the boundary condition. If a material is changed after the boundary condition is created then the incorrect emissivity is displayed and the boundary conditions should be refreshed.

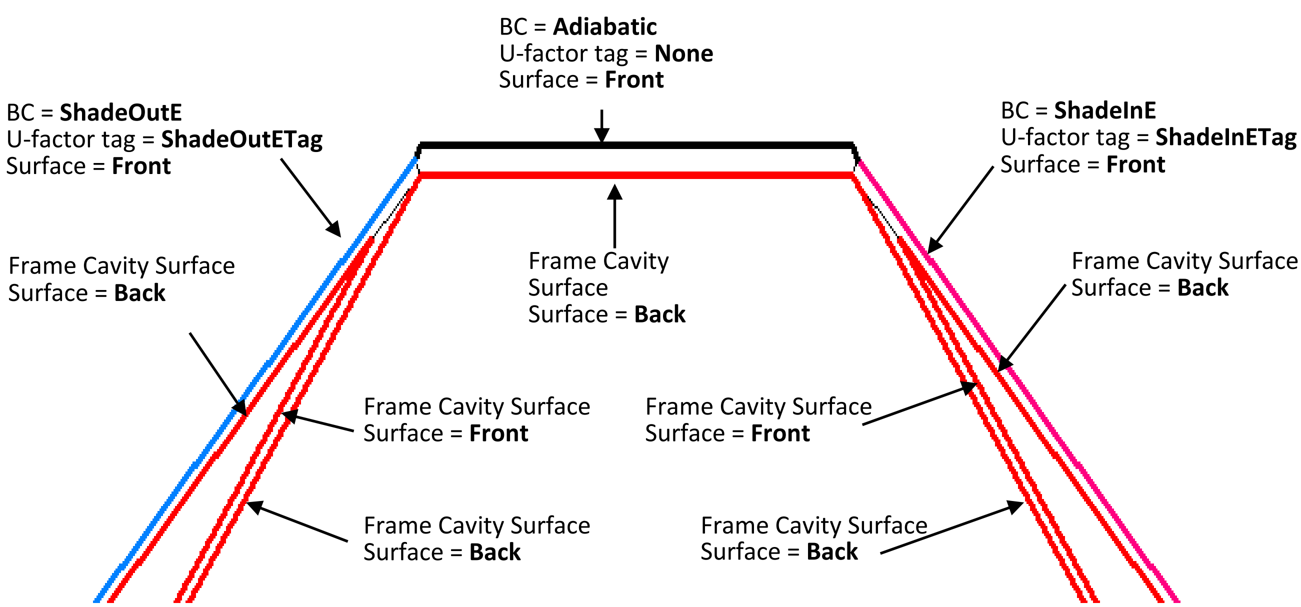


Figure 19-83.Setting the Boundary Conditions

19.5.6. THERM: Calculate the Model for Error Checking

Calculate the model before progressing to ensure there are no errors, such as voids in the mesh. If changes are required, ensure all polygon and boundary conditions are re-linked to shade materials.

19.5.7. THERM: Create an array of shade components as needed

Depending on the shading system being modeled, it may be necessary to draw multiple sets of the basic shading component.

For example, for cellular shades, a single cell is drawn and simulated, and once that model is found to be error-free, a series of 11 of those cells are drawn, stacked on top of each other.

When modeling roller shutters with opaque slats, only three of the main shutter components are needed in the model.

Determining the number of components needed for the complete THERM model will depend on the shading layer being modeled.

19.5.8. WINDOW: Create the Shading Layer

When the shading system model has been created in THERM, with the array of needed components, it is then used to define the shading layer in the WINDOW Shading Layer Library.

In WINDOW, go to the Shading Layer Library, and create a new record

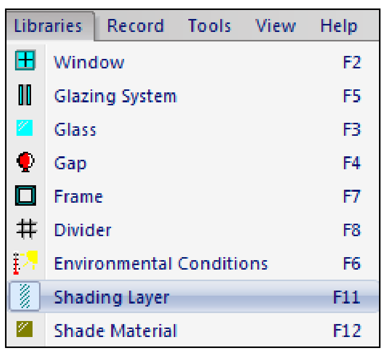


Figure 19-84. Select the Shading Layer Library

- Set Type to Therm File (*.thmx)
- BSDF File: Browse to thmx file created in Term
- Click the Calculate button to calculate the BSDF file. NOTE: This calculation will take around 70 minutes.

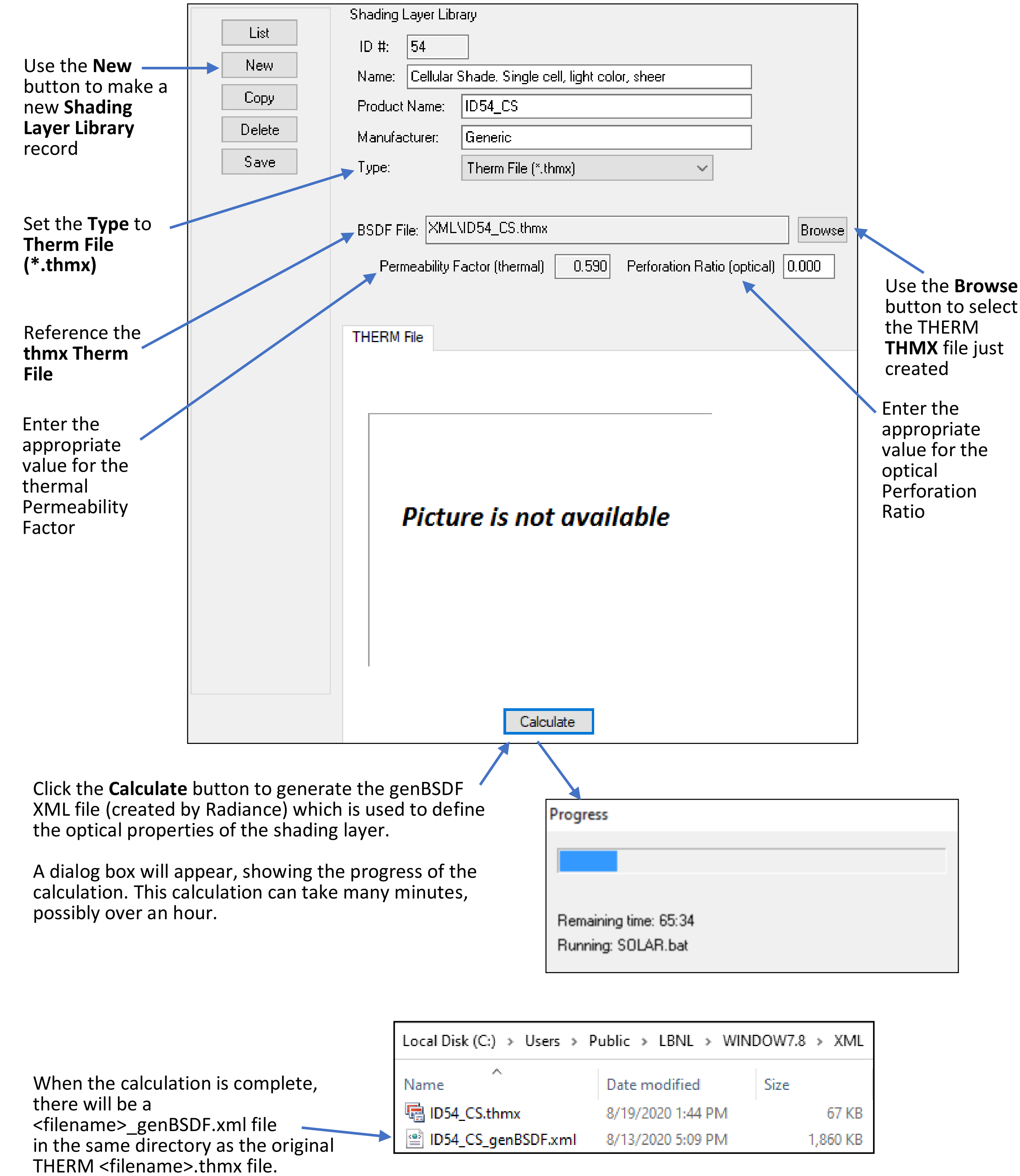


Figure 19-85. Create a new Shading Layer Library record,set the BSDF file to the THERM thmx file just created, enter the appropriate values for Permeability Factor and Perforation Ratio, then click the Calc button to create the genBSDF file.

The properties of the material from the WINDOW database are stored in the THMX file, meaning that once the file is saved, it is independent of any subsequent changes to the WINDOW database used to produce it. Therefore, if the properties of materials used in the WINDOW database change, the THMX file must also be regenerated in order to keep the properties up-to-date.


```
<Material Name="CS03:CS03_glueline.txt" Type="5" Conductivity="0.120000" Tir="0.000224" EmissivityFront="0.777410" EmissivityBack="0.781640" RGBColor="0x4951EB">
    <Property Side="Front" Range="Visible" Specularity="Direct" T="0.000000" R="0.000000"/>
    <Property Side="Front" Range="Visible" Specularity="Diffuse" T="0.269345" R="0.711613"/>
    <Property Side="Front" Range="Solar" Specularity="Direct" T="0.000000" R="0.000000"/>
    <Property Side="Front" Range="Solar" Specularity="Diffuse" T="0.267214" R="0.686956"/>
    <Property Side="Back" Range="Visible" Specularity="Direct" T="0.000000" R="0.000000"/>
    <Property Side="Back" Range="Visible" Specularity="Diffuse" T="0.269345" R="0.689204"/>
    <Property Side="Back" Range="Solar" Specularity="Direct" T="0.000000" R="0.000000"/>
    <Property Side="Back" Range="Solar" Specularity="Diffuse" T="0.267214" R="0.665194"/>
</Material>
```


Figure 19-86. The THMX file (a text file) is independent of the WINDOW database where the THERM materials were imported from

Set the **Permeability Factor (thermal):**

This is the airflow permeability for the shading layer system. For single layer systems, such as pleated shades, the permeability factor (thermal) of the single material is entered. For multiple layer systems, the shade material with the lowest permeability factor (thermal) in the airflow critical path is used. The critical path for several systems is illustrated in the figure below. This must be entered into the Shading Layer definition before clicking the Calc button.

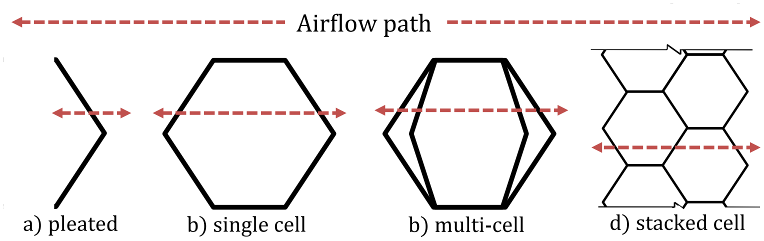


Figure 19-87. Airflow critical path through cellular shade sytems. The shade material with the lowest permeability factor in the airflow critical path determines the Permeability Factor.

Set the Perforation Ratio (optical):

Optical properties of the shading layer are calculated with the Calculate button by Radiance. This calculation is based on only the material properties and geometry in the Therm file (*.thmx). Large scale perforations in a shade layer, which are not accounted for in the material properties or therm file (*.thmx) can accounted for by determining the equivillent open area of the perforations and entering the ratio of open area to total layer area as the Perforation Ratio (optical). Perforations must be in a regular repeating pattern and distributed over the entire layer area. The primary example for a shading layer of the Therm file (*.thmx) type with Perforation Ratio (optical) is a roller shutter with perforated slats. The Perforation Ratio (optical) is calculated using the methods described in the Perforated Screens section. This must be entered into the Shading Layer definition before clicking the Calc button.

19.5.9. WINDOW: Add the Shading Layer to a Glazing System

Now that the shading layer has been defined in the Shading Layer Library, it can be added to a glazing system in the Glazing System Library in the same manner as any Shading Layer.

19.6. Insulating Shade Layers with Non-Standard Geometry: Cellular Shades

The steps in this section describe modeling a cellular shade which has materials with non-zero transmittance (visible, solar, and/or infrared). This example is a single cell cellular shade.

19.6.1. WINDOW: Define Shade Layer Materials

The cellular shade fabrics shown in the figure below were measured in a spectrophotometer, imported into Optics, and then imported into the WINDOW Shade Material Library.

Shade Material Library (C:\Users\Public\LBNL\WINDOW7.7\w7.mdb)

ID	Name	ProductName	Manufacturer	Source
31033	C23_innerwalls.txt	C23 White/Alumium back	Hunter Douglas	CGDB
31034	C22-951_innerwalls.txt	C22-951 Inner wall	Hunter Douglas	CGDB
31035	C22-951_outerwalls.txt	C22-951 Outer wall	Hunter Douglas	CGDB
31036	C22-951_glueline.txt	C22-951 Glue line	Hunter Douglas	CGDB
31037	C82_TransparentPlastic.txt	C82 Transparent plastic	Hunter Douglas	CGDB
31038	D2_WhiteWallMaterial.txt	D2 White wall	Hunter Douglas	CGDB
31039	D7_WhiteOnSilverBack.txt	D7 White on Silver back	Hunter Douglas	CGDB
31040	D8_WhiteSheer.txt	D8 - White sheer	Hunter Douglas	CGDB

Figure 19-88. The example materials above in the WINDOW Shade Material Library are used to define cellular shade surfaces in THERM

19.6.2. THERM: Therm Preference Settings

In THERM, in the **Options** menu, **Preferences** tab, set the following options:

- **Automatic XML Export on Save** = Checked
- **Radiance Mode** = Checked
    - Checking Radiance mode will turn the THERM drawing background gray so that it's obvious you are in Radiance mode.

19.6.3. THERM: Add the WINDOW Shade Materials to the THERM Material Library

Import the WINDOW Shade Material Library records needed to define the cellular shade in THERM.

In the **Material Definitions** dialog box, click the **Load Shade Material** button to add a Shade Material record from WINDOW to be used to define the material properties in THERM. This button only appears if you have checked "Radiance Mode" in Options/Preferences.

When the materials from WINDOW have been imported, they will be available from the THERM pulldown list of materials when defining polygons for the THERM model.

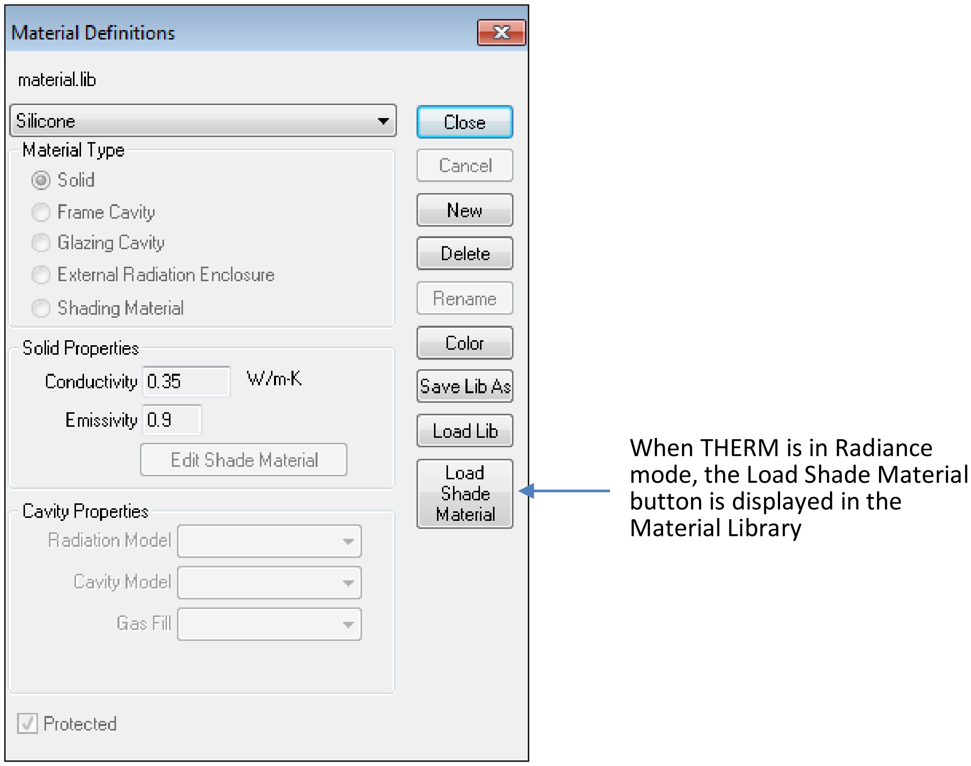


Figure 19-89. Click on the Load Shade Material button to add a WINDOW Shade Material to the THERM Material Library (this button only appears if "Radiance Mode" is checked)

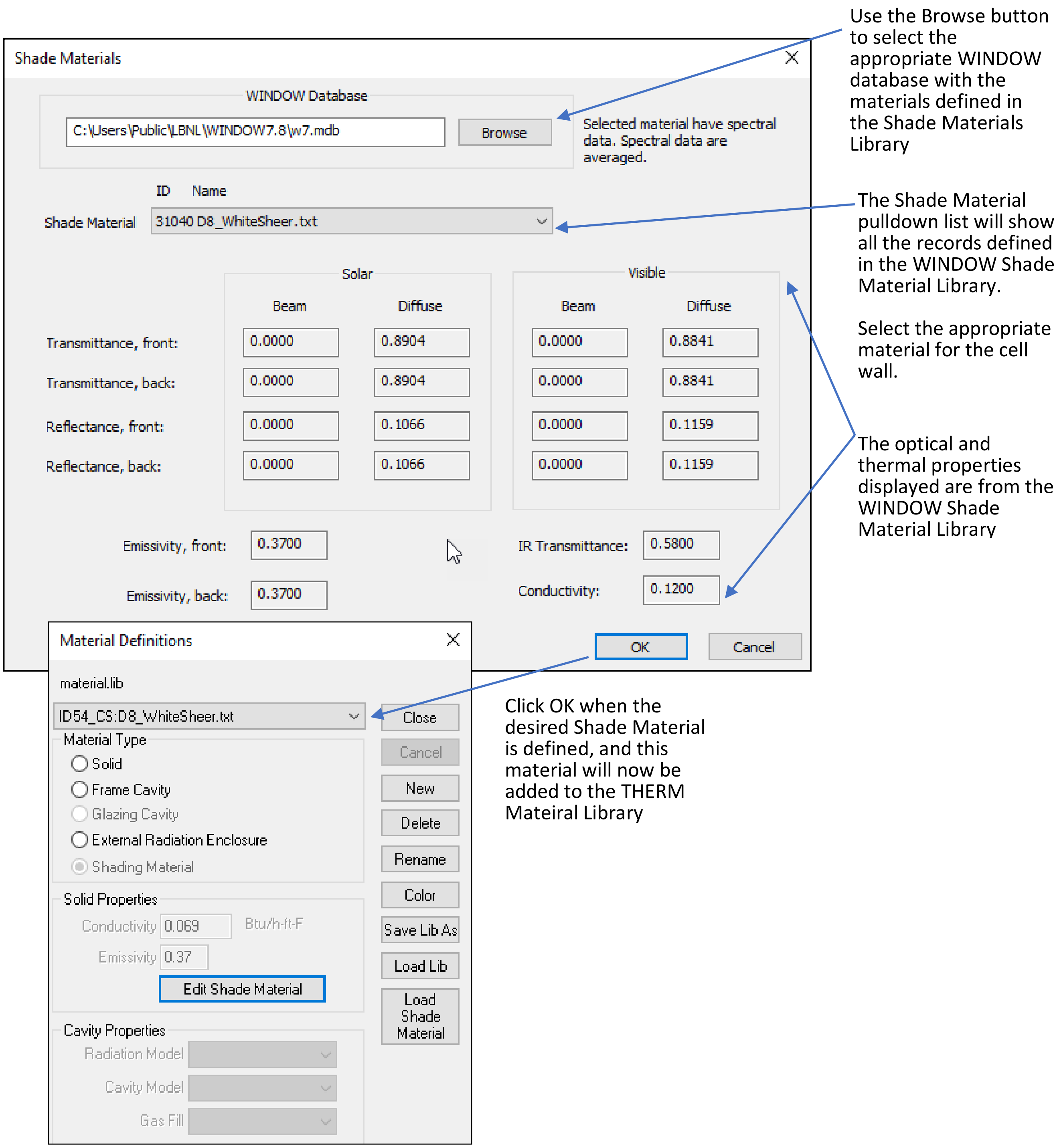


Figure 19-90. Select the materials from the WINDOW database used to define the cellular shade fabric walls in THERM.

19.6.4. THERM: Define Shade Geometry

The next step is to define the geometry of the cellular shade in THERM.

19.6.4.1. Generate DXF File for Cell Geometry

In the CAD program of your choice, create the geometry of a single cell (repeating pattern), including the thickness for each cell wall, and save as a DXF file (*.dxf). Center the cell at 0,0.

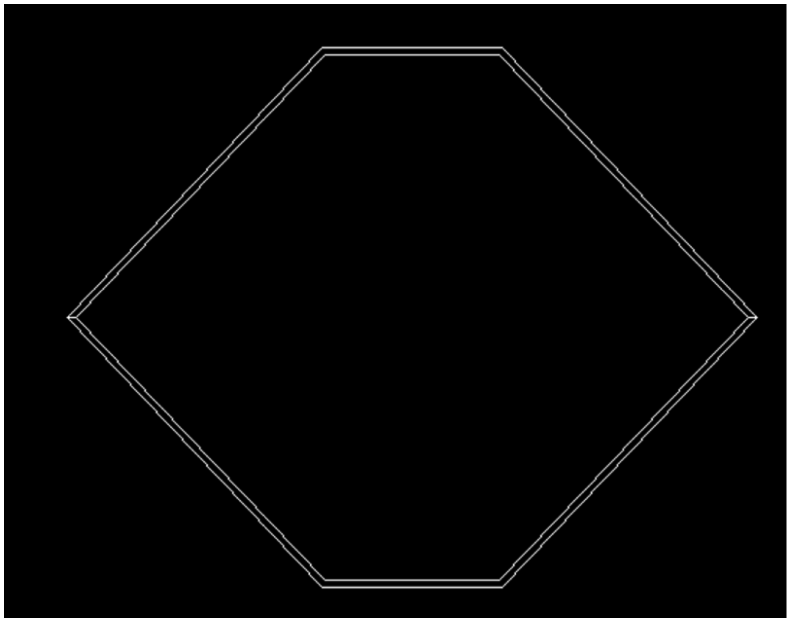


Figure 19-91. Draw the cell geometry in a CAD program and export as a DXF file.

19.6.4.2. Import DXF as Underlay into THERM

Import the DXF as an underlay into THERM

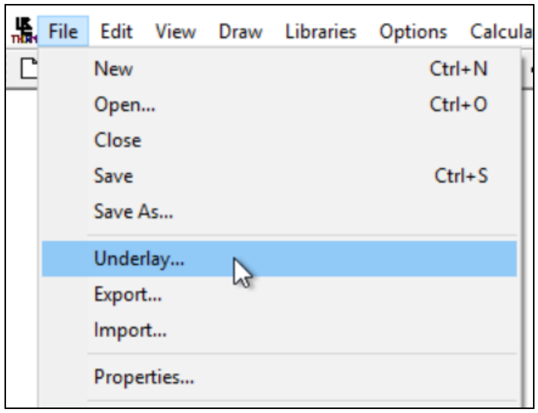


Figure 19-92. Import the DXF file as an underlay.

From the Underlay dialog box, browse to the *.dxf file and ensure that in the Scaling section, the units are match the *.dxf correctly, i.e., SI (mm) or IP (inches).

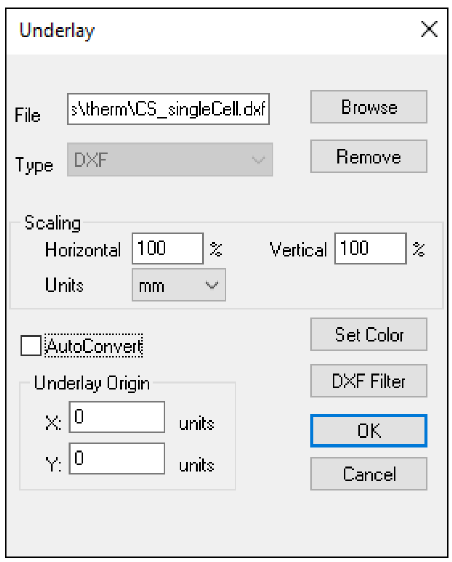


Figure 19-93. In the Underlay dialog box, make sure that Scaling has the correct setting for Units.

THERM will display the underlay as a light gray drawing

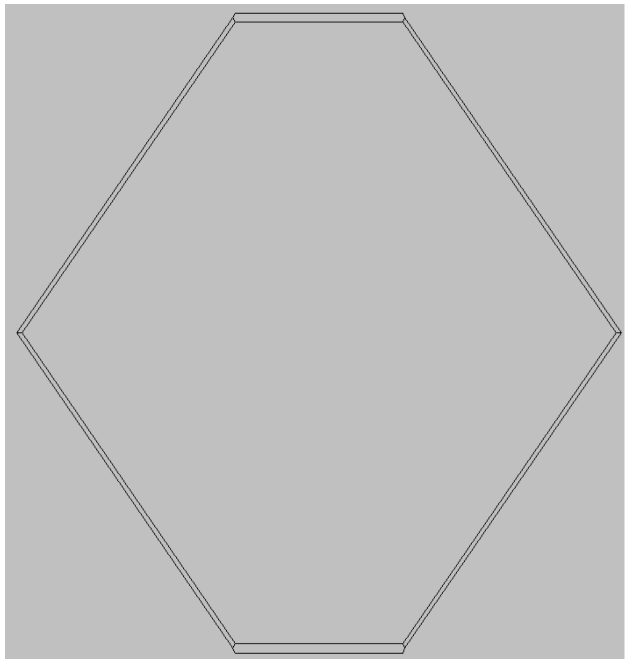


Figure 19-94. The underlay imported into THERM.

19.6.4.3. Create Polygons from the Underlay

Draw the polygons representing the walls of the cell(s) and specify the correct material for each polygon, from the materials created in WINDOW that are now available in the THERM Material Library.

Draw the polygons representing the walls of the cell(s), and select the appropriate material for the polygons, in this case the newly created material.

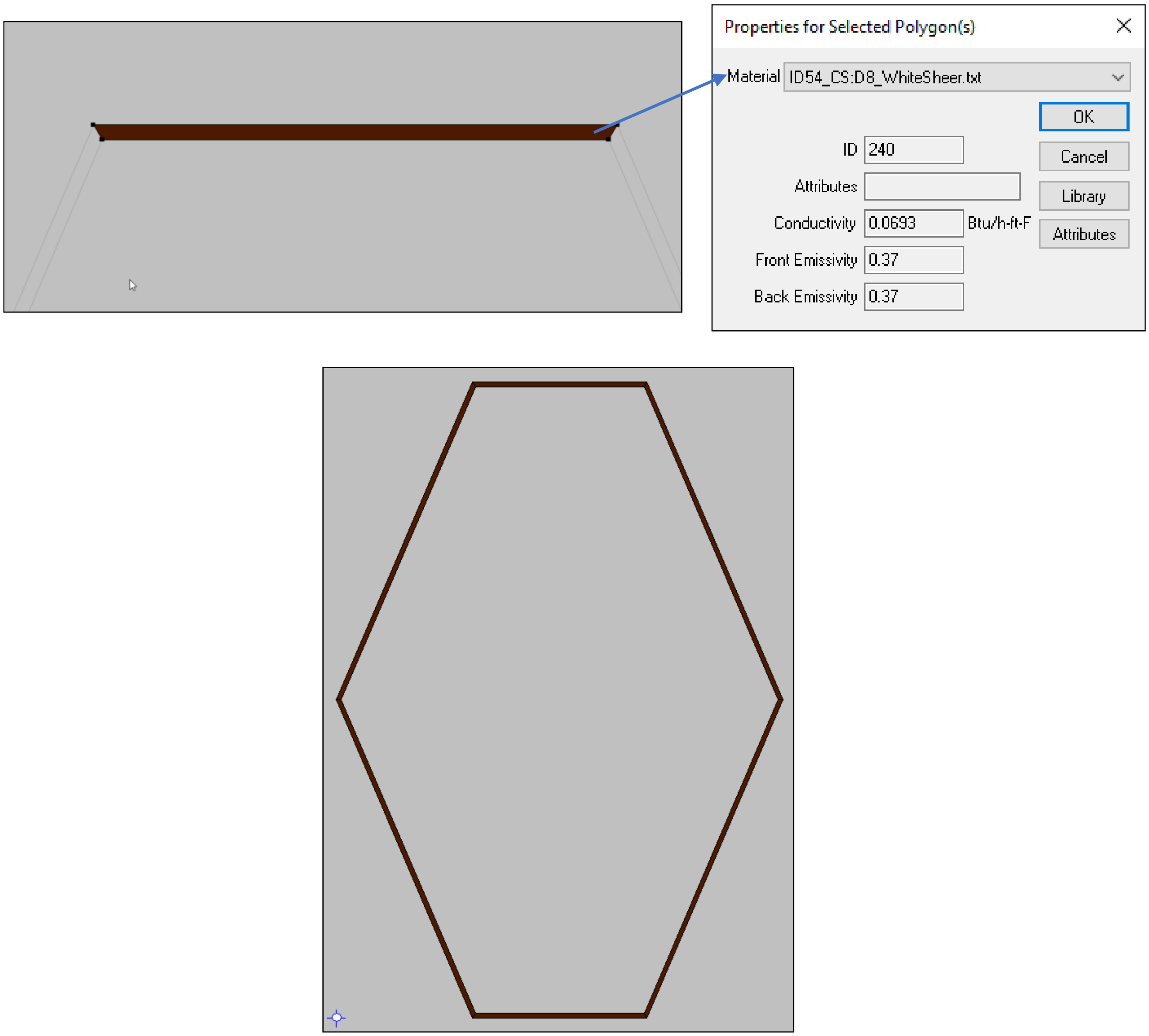


Figure 19-95. Draw all the polygons by tracing the underlay and assigne the materials as needed.

Create polygons for spaces between the cell walls and assign them to the “Frame cavity NFRC 100” material

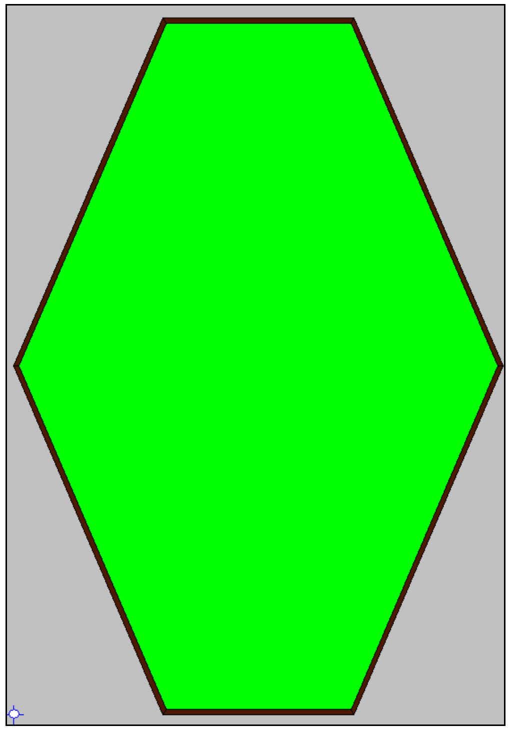


Figure 19-96. Fill the spaces between the cell walls with Frame Cavity NFRC 100.

19.6.4.4. Generate Boundary conditions

Generate the boundary conditions for the model

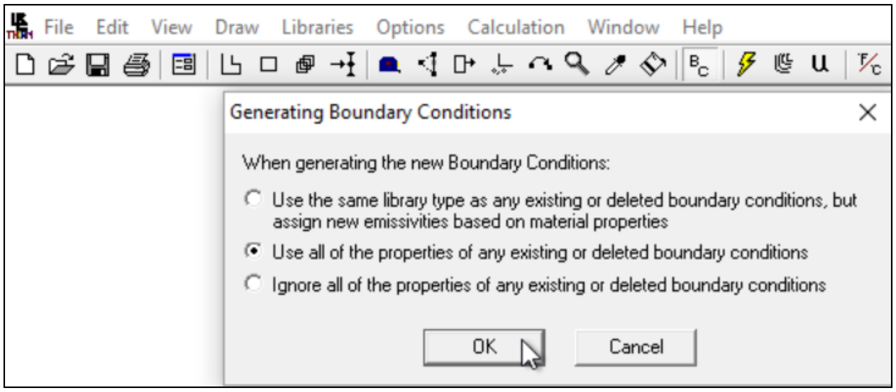


Figure 19-97. Generate the Boundary Conditions

The emissivity associated with a boundary condition is static to the material that was present when creating the boundary condition. If a material is changed after the boundary condition is created then the incorrect emissivity is displayed and the boundary conditions should be refreshed.

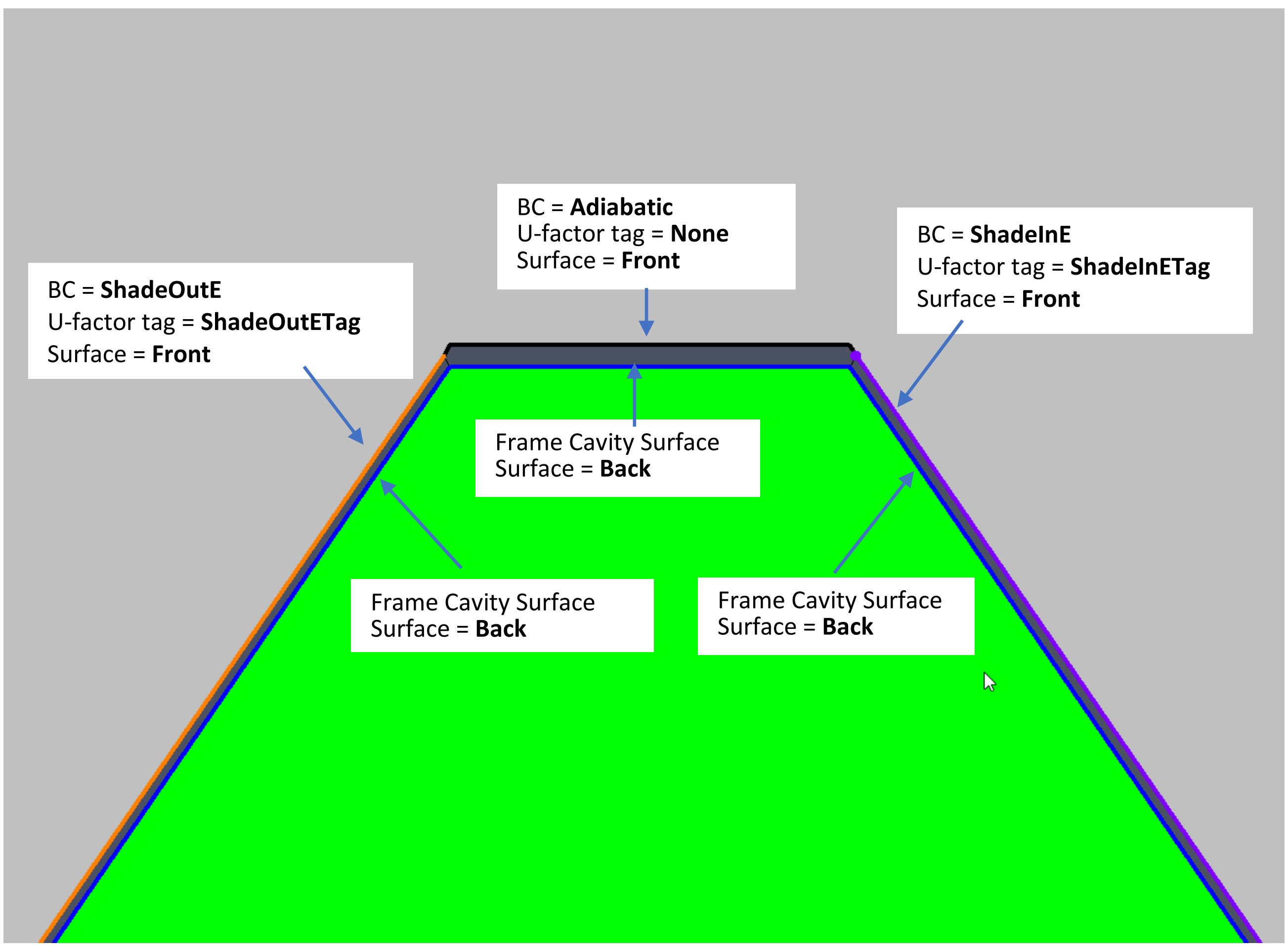


Figure 19-98.Setting the Boundary Conditions

The boundary conditions should be set as follows:

There are two predefined boundary conditions and U-factor tags for the interior and exterior boundary conditions of the cell geometry

- Exterior surfaces
    - Boundary Condition: **ShadeOutE**
    - U-factor surface tag: **ShadeOutETag**

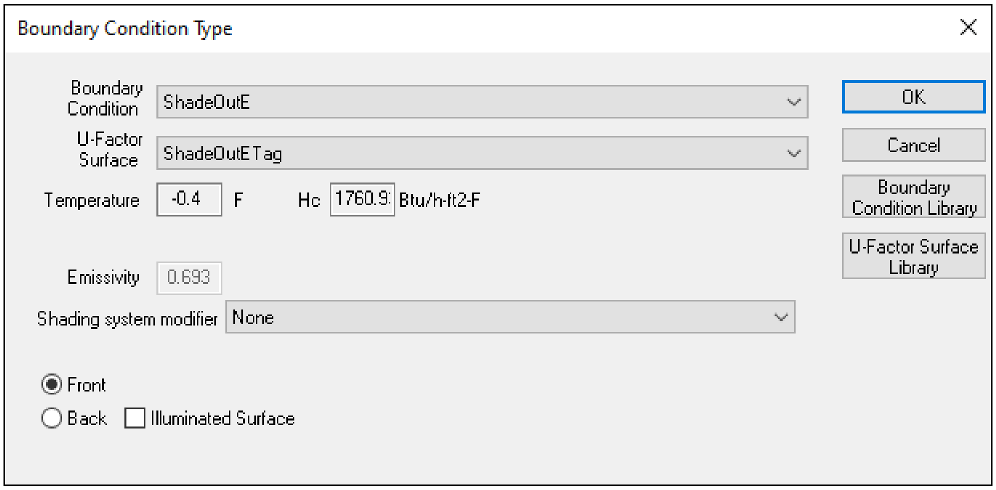


Figure 19-99. ShadeOutE Boundary Condition

- Interior surfaces
    - Boundary Condition: **ShadeInE**
    - U-factor surface tag: **ShadeInETag**

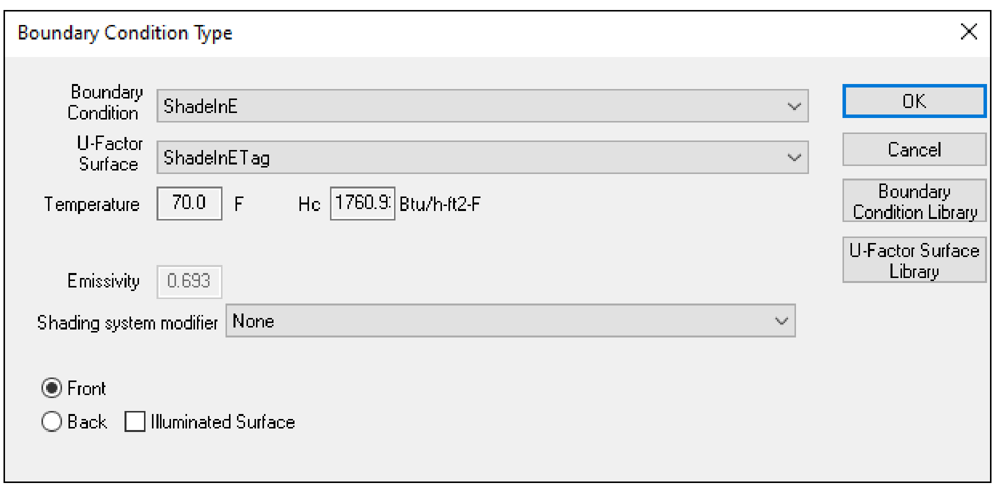


Figure 19-100. ShadeInE Boundary Condition

19.6.4.5. Calculate the Model for Error Checking

Calculate the model before progressing to ensure there are no errors. If changes are required, ensure all polygon and boundary conditions are re-linked to shade materials

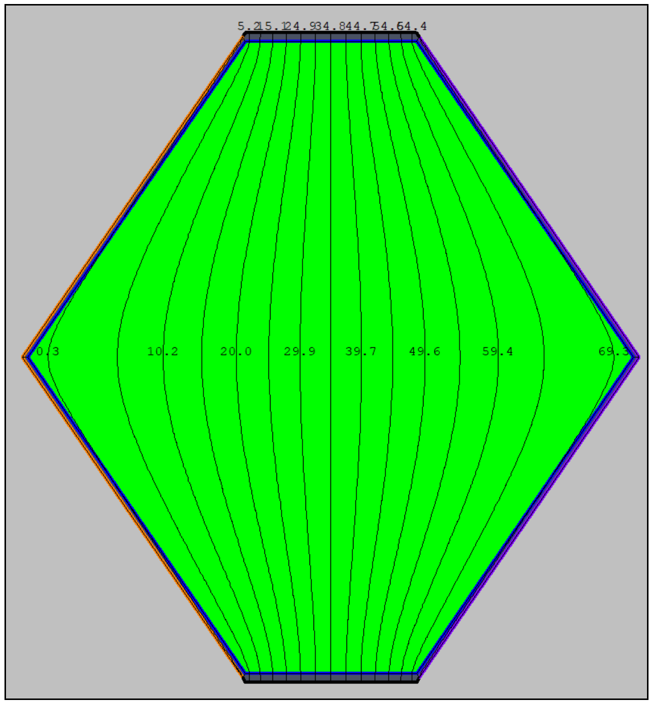


Figure 19-101. Calculate the model to make sure there are no meshing errors

19.6.4.6. Create an array of cells

To finish the model, create an array of cells with 5 cells above and 5 cells below the center cell

See the THERM User Manual for detailed instructions about how to copy and paste polygons within the same file or between different files.

Leave boundary conditions visible to ensure the boundary condition settings are copied along with the polygons.

- Set locator to reference point

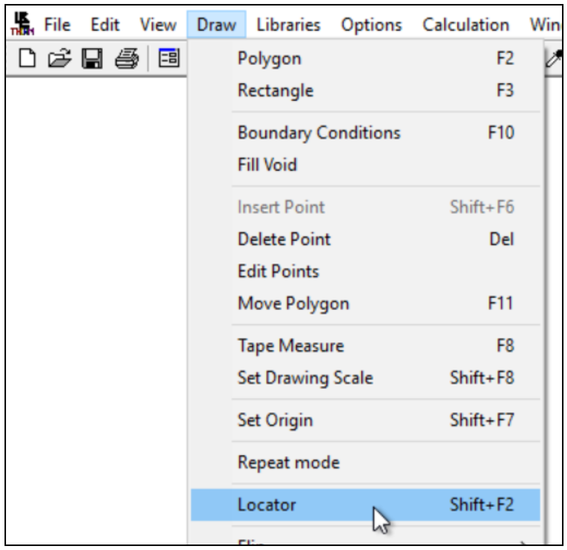


Figure 19-102. Select the Draw/Locator menu option to set the locator

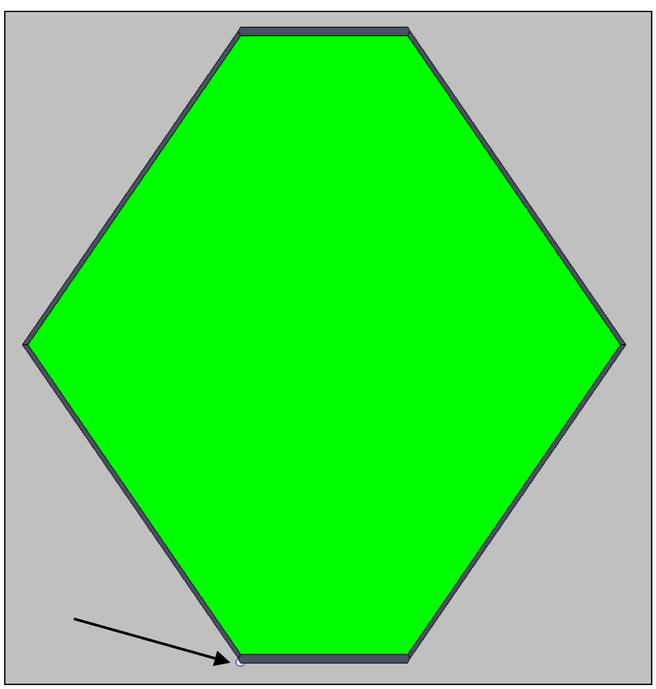


Figure 19-103. Set the locator in the lower left corner of the model

- Select objects to be copied (shift + click) until all are selected and copy (Ctrl + C)

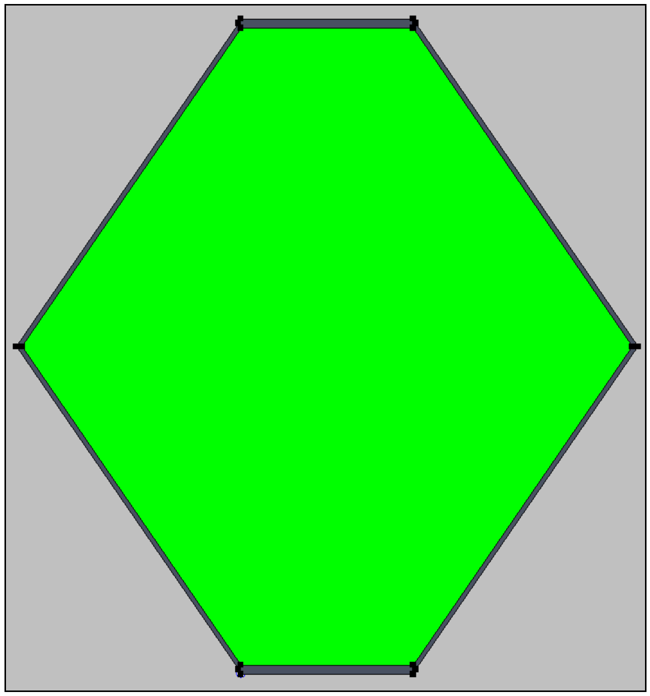


Figure 19-104. Select the objects to be copied

- Set locator to destination point

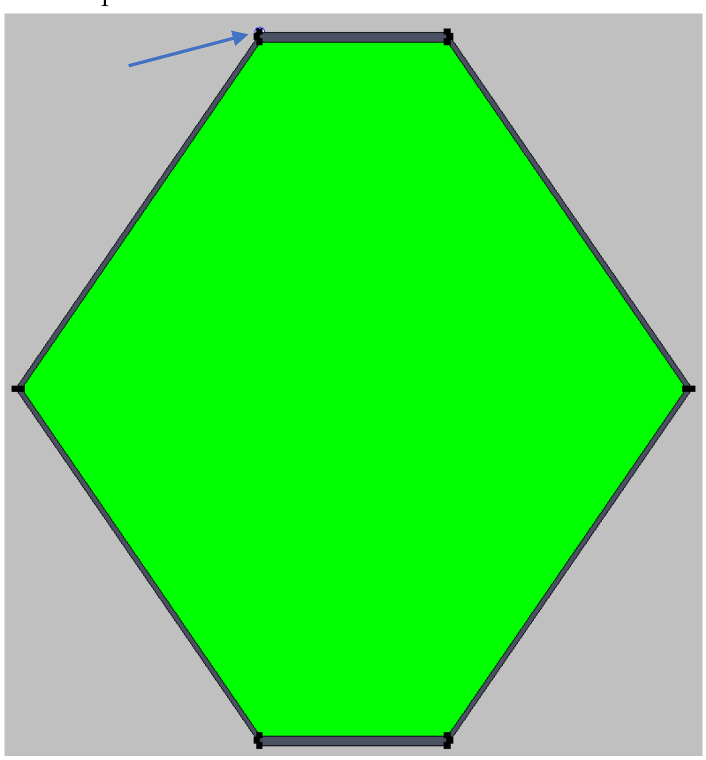


Figure 19-105.Set the locator to the destination point.

- Past the copied geometry (Ctrl + V)

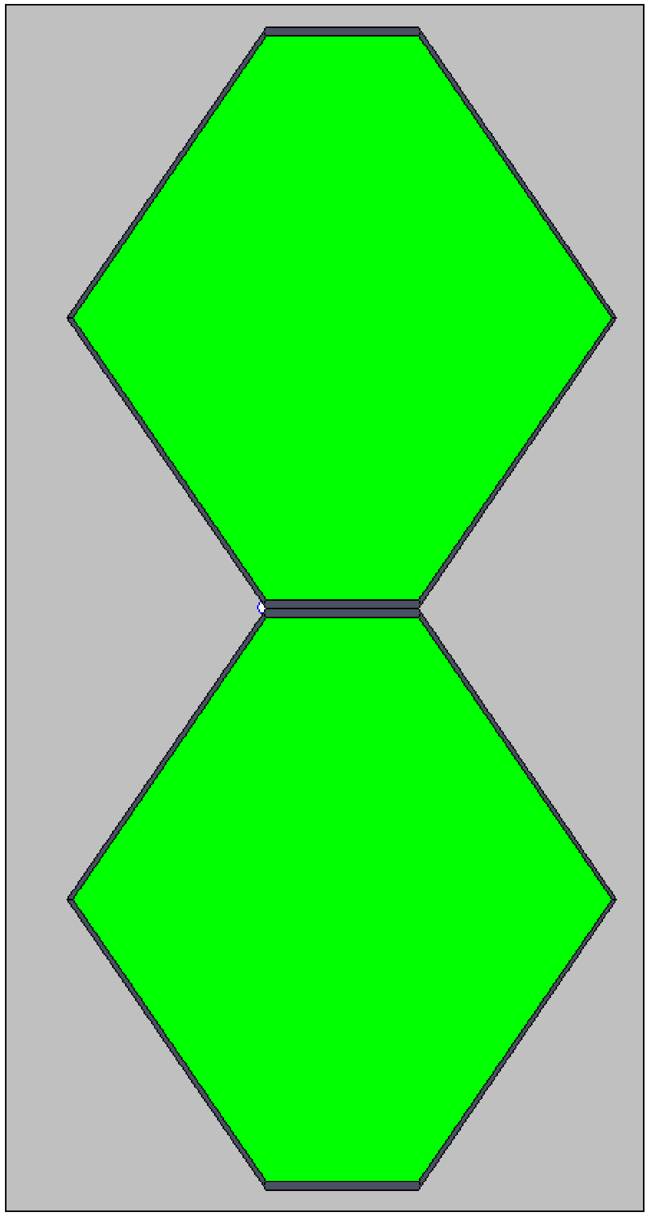


Figure 19-106. Paste the copied geometry

- Repeat until array of cells with 5 cells above and 5 cells below the center cell is created, for a total of 11 cells.

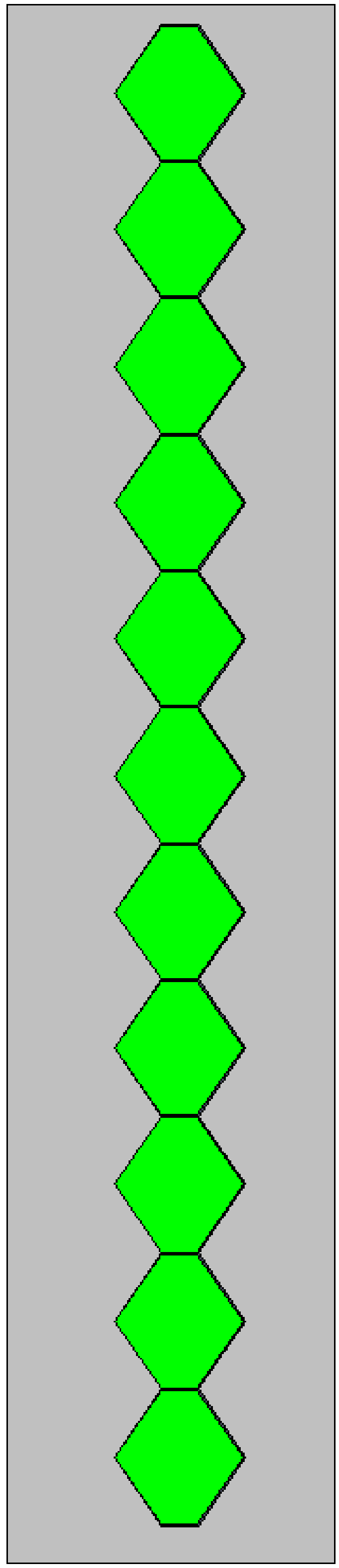


Figure 19-107. Repeat until there are 5 cells above and 5 cells below the center cell

- Set all the interior boundary condition segments to **ShadeInE** and U-Factor Surface tag **ShadeInETag**

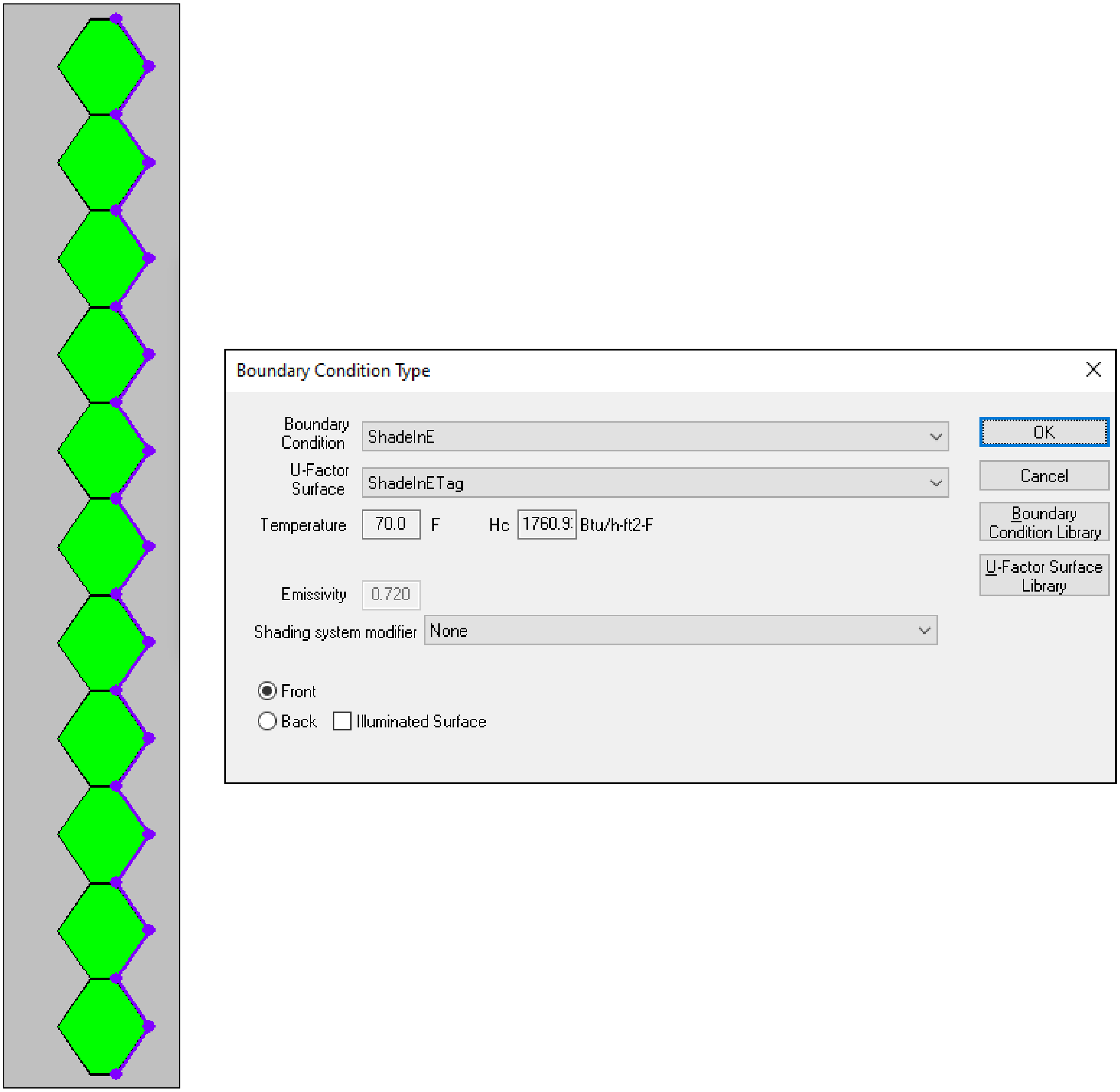


*Figure 19-108. Set the exterior boundary conditions to **ShadeInE** and the U-factor Surface Tag to **ShadeInETag***

- Set all the exterior boundary condition segments to **ShadeOutE** and U-Factor Surface tag **ShadeOutETag**

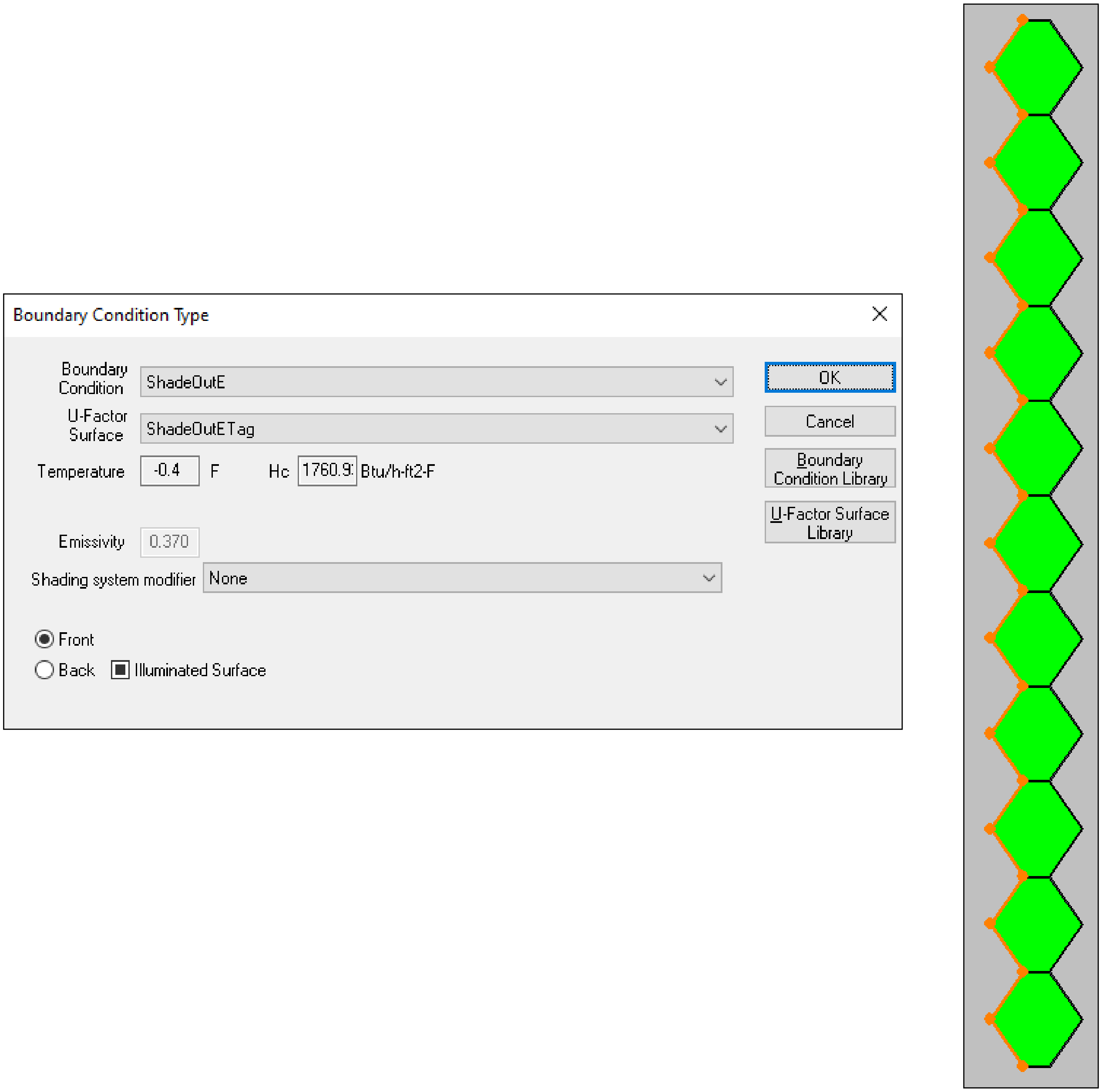


*Figure 19-109. Set the exterior boundary conditions to **ShadeOutE** and the U-factor Surface Tag to **ShadeOutETag***

- For the center cell, check the "Illumination source" for the left most (outer) walls. If an even number of cells is required for convergance then either cell adjacent to the center (above or below) may be used.

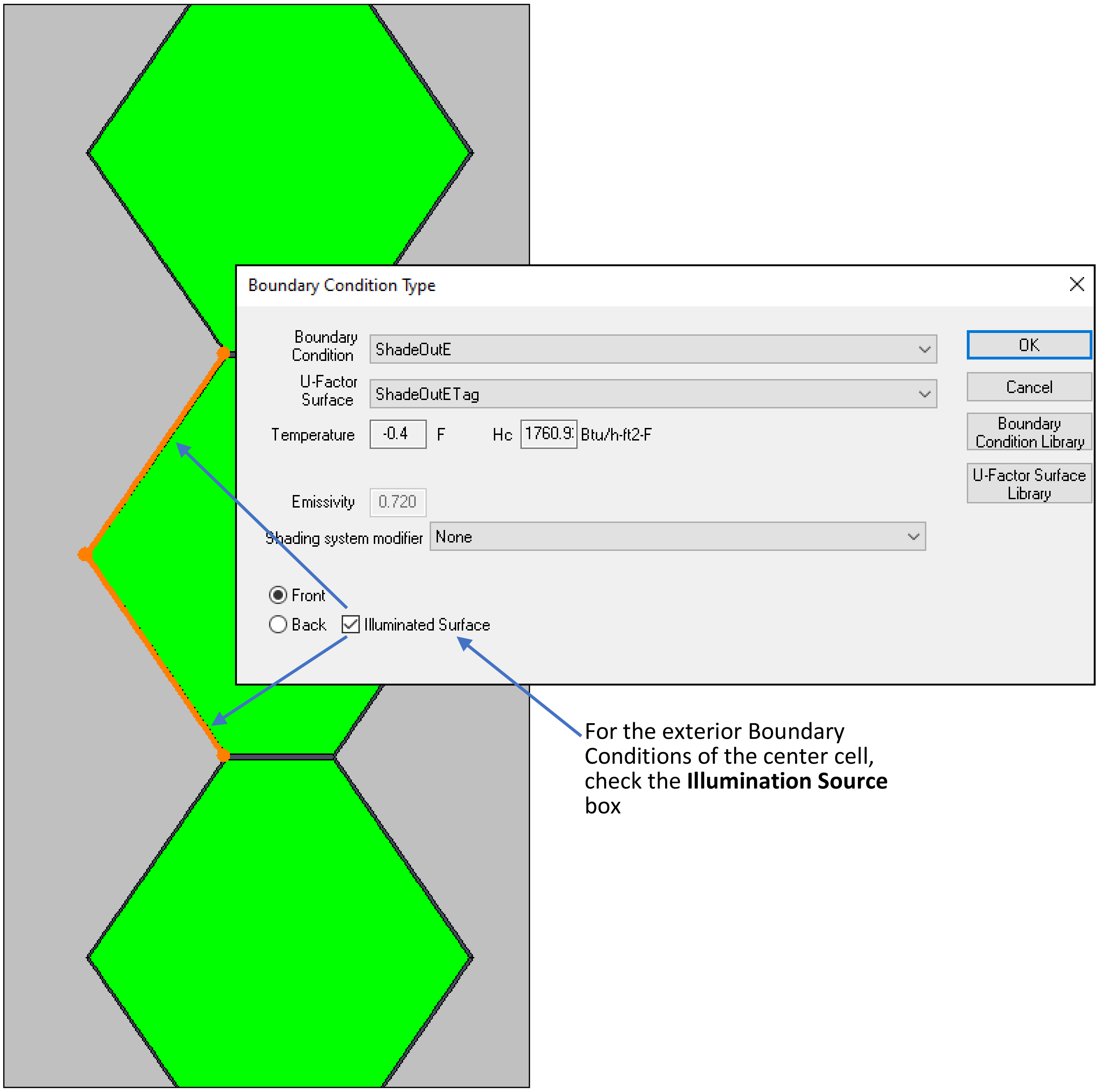


Figure 19-110. Check the "Illumination Source" for the exterior Boundary Conditions of the center cell in the stack.

19.6.5. WINDOW: Create the Shading Layer

In WINDOW, go to the Shading Layer Library, and create a new record

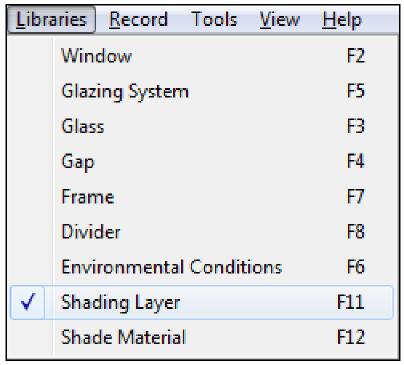


Figure 19-111. Select the Shading Layer Library

- Set Type to Therm File (*.thmx)
- BSDF File: Browse to the thmx file created in Therm

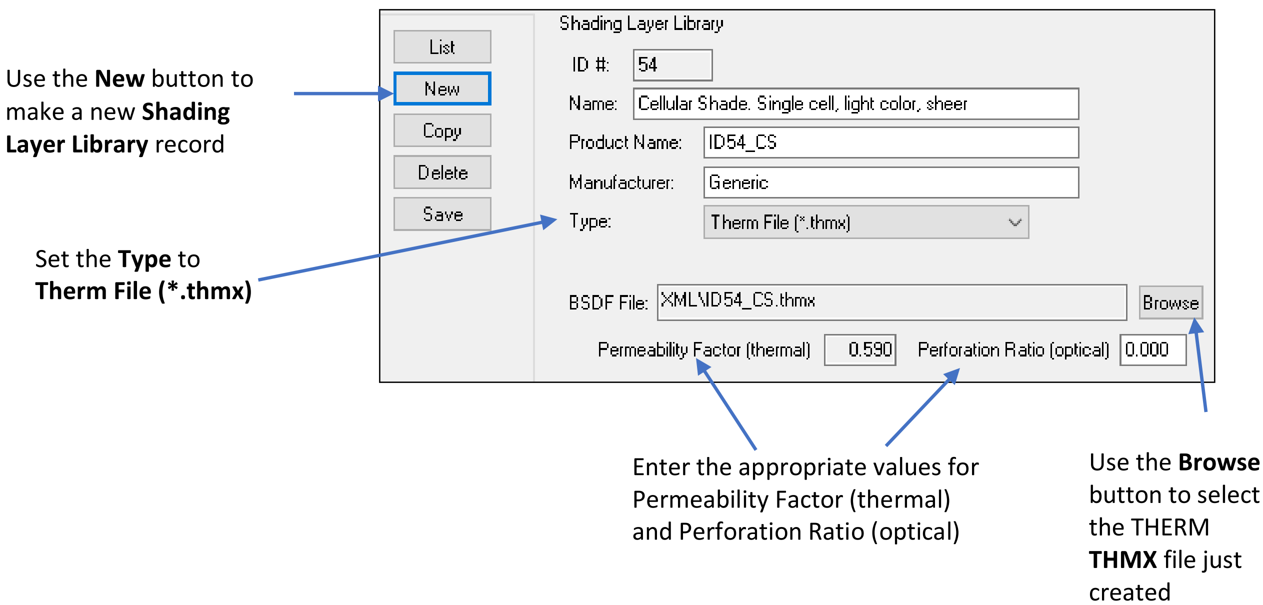


Figure 19-112. Create a new Shading Layer Library record and set the BSDF file to the THERM thmx file just create, enter the appropriate values for Permeability Factor and Perforation Ratio, then click the Calc button to create the genBSDF file..

- Calculate BSDF file by clicking the Calculate button under the THERM File tab. NOTE: This calculation will take around 70 minutes.

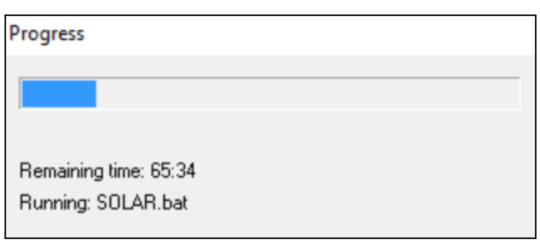


Figure 19-113. Calculating the BSDF file can take over an hour, depending on the computer.

The properties of the material from the WINDOW database are stored in the THMX file, meaning that once the file is saved, it is independent of any subsequent changes to the WINDOW database used to produce it. Therefore, if the properties of materials used in the WINDOW database change, the THMX file must also be regenerated in order to keep the properties up-to-date.

```
<Material Name="CS03:CS03_glueline.txt" Type="5" Conductivity="0.120000" Tir="0.000224" EmissivityFront="0.777410" EmissivityBack="0.781640" RGBColor="0x4951EB">
    <Property Side="Front" Range="Visible" Specularity="Direct" T="0.000000" R="0.000000"/>
    <Property Side="Front" Range="Visible" Specularity="Diffuse" T="0.269345" R="0.711613"/>
    <Property Side="Front" Range="Solar" Specularity="Direct" T="0.000000" R="0.000000"/>
    <Property Side="Front" Range="Solar" Specularity="Diffuse" T="0.267214" R="0.686956"/>
    <Property Side="Back" Range="Visible" Specularity="Direct" T="0.000000" R="0.000000"/>
    <Property Side="Back" Range="Visible" Specularity="Diffuse" T="0.269345" R="0.689204"/>
    <Property Side="Back" Range="Solar" Specularity="Direct" T="0.000000" R="0.000000"/>
    <Property Side="Back" Range="Solar" Specularity="Diffuse" T="0.267214" R="0.665194"/>
</Material>
```

Figure 19-114. The THMX file (a text file) is independent of the WINDOW database where the THERM materials were imported from

Set the **Permeability Factor (thermal):**

This is the airflow permeability for the shading layer system. For single layer systems, such as pleated shades, the permeability factor (thermal) of the single material is entered. For multiple layer systems, the shade material with the lowest permeability factor (thermal) in the airflow critical path is used. The critical path for several systems is illustrated in the figure below. This must be set befor clicking the Calc button, which runs Radiance.

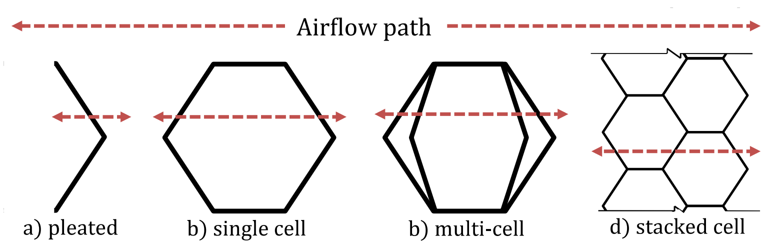


Figure 19-115. Airflow critical path through cellular shade sytems. The shade material with the lowest permeability factor in the airflow critical path determines the Permeability Factor.

Set the Perforation Ratio (optical):

Optical properties of the shading layer are calculated with the Calculate button by Radiance. This calculation is based on only the material properties and geometry in the Therm file (*.thmx). Large scale perforations in a shade layer, which are not accounted for in the material properties or therm file (*.thmx) can accounted for by determining the equivillent open area of the perforations and entering the ratio of open area to total layer area as the Perforation Ratio (optical). Perforations must be in a regular repeating pattern and distributed over the entire layer area. The primary example for a shading layer of the Therm file (*.thmx) type with Perforation Ratio (optical) is a roller shutter with perforated slats. The Perforation Ratio (optical) is calculated using the methods described in the Perforated Screens section. This must be set befor clicking the Calc button, which runs Radiance.

19.7. Insulating Shade Layers with Non-Standard Geometry: Roller Shutters

The example below shows the steps to use when the layer has materials with zero transmittance (visible, solar, and/or infrared), in this case a roller shutter, but these steps can be used for any non-standard shade geometry, with opaque materials, that is defined using THERM.

19.7.1. WINDOW: Define Shade Layer Library Materials

Even though the materials are opaque, define them in WINDOW (from data measured in a spectrophotometer, imported into Optics, and then imported into the WINDOW Glass Library) so that when they are imported into THERM, they will have more properties (such as spectral data) defined than ordinary THERM materials. These properties will be used in Radiance for reflectance calculations that will be influenced by the THERM model geometry.

There are two roller shutter examples presented here, one that is insulated and one that is not. The primary modeling difference is in the boundary condition definitions.

19.7.2. THERM: Therm Preference Settings

In THERM, in the **Options** menu, **Preferences** tab, set the following options:

- **Automatic XML Export on Save** = Checked
- **Radiance Mode** = Checked
  This will cause the THERM drawing background to turn gray, as an indication that Radiance mode is on.

19.7.3. THERM: Add the WINDOW Shade Materials to the THERM Material Library

Once the appropriate materials have been defined in the WINDOW Shade Material Library, they need to be added to the THERM Material Library.

19.7.4. THERM: Define Shade Geometry for one shade segment

The next step is to define the geometry of the shade layer in THERM.

The THERM file will represent the geometry of the roller shutter. There are many ways to generate this geometry in THERM, but the most common method is to create the geometry in a CAD file, and export a DXF file that can be imported into THERM.

The DXF file can either be traced in THERM or, if created correctly, THERM can autoconvert the polygons.

The recommendation is to create one of the shading system components in THERM, generate boundary conditions and make sure it calculates before generating the multiple components that will be needed to define the final shading system.

When the polygons have been defined for the model, the materials imported from WINDOW into the THERM Shade Material Library should be assigned to the outer layers of the geometry. Inner polygons can be defined with the normal THERM Material Library.

In the case of this roller shutter example, the same material, White Aluminum, is used on both the inside and outside of the model. The following guidelines apply to modeling opaque materials

- For outer layers, always use materials that have been measured, even if the material is opaque. Therefore, these materials should be imported from the WINDOW Shade Materials Library

- For inner layers, if they are surround by opaque materials (such as in this example, the insulation), then those surrounded materials can be selected from the standard THERM Material Library, and do not need to be imported from the WINDOW Shade Material Library

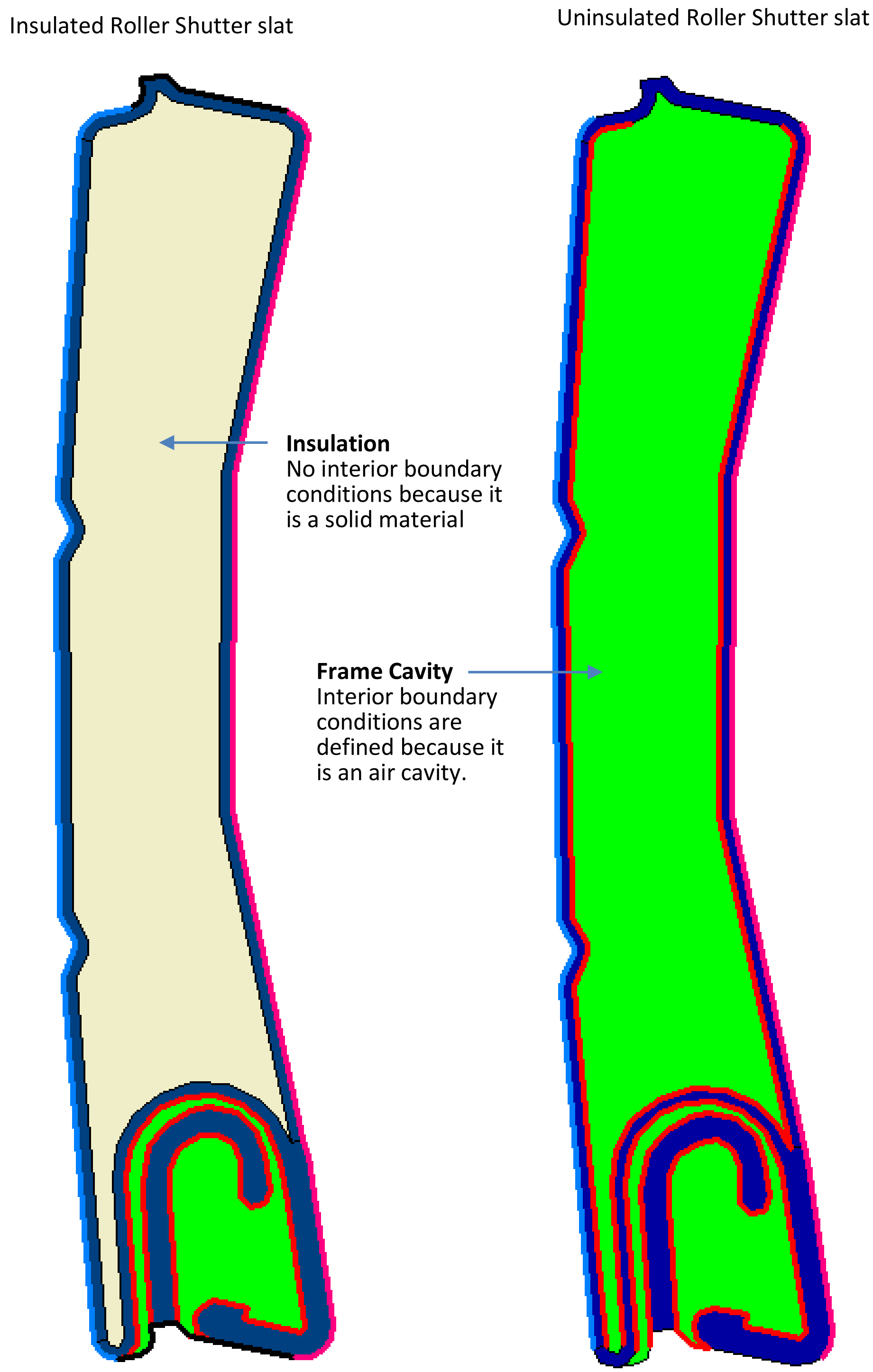


Figure 19-116. The boundary conditions will be defined differently depending on whether the roller shutter slat component is air filled (hollow) or uninsulated.

19.7.5. THERM: Generate Boundary conditions for one shade segment

Generate the boundary conditions for the model

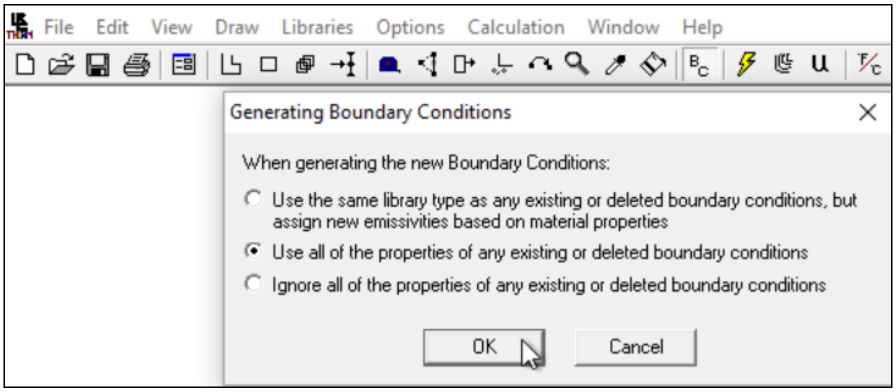


Figure 19-117. Generate the Boundary Conditions

The emissivity associated with a boundary condition is static to the material that was present when creating the boundary condition. If a material is changed after the boundary condition is created then the incorrect emissivity is displayed and the boundary conditions should be refreshed.

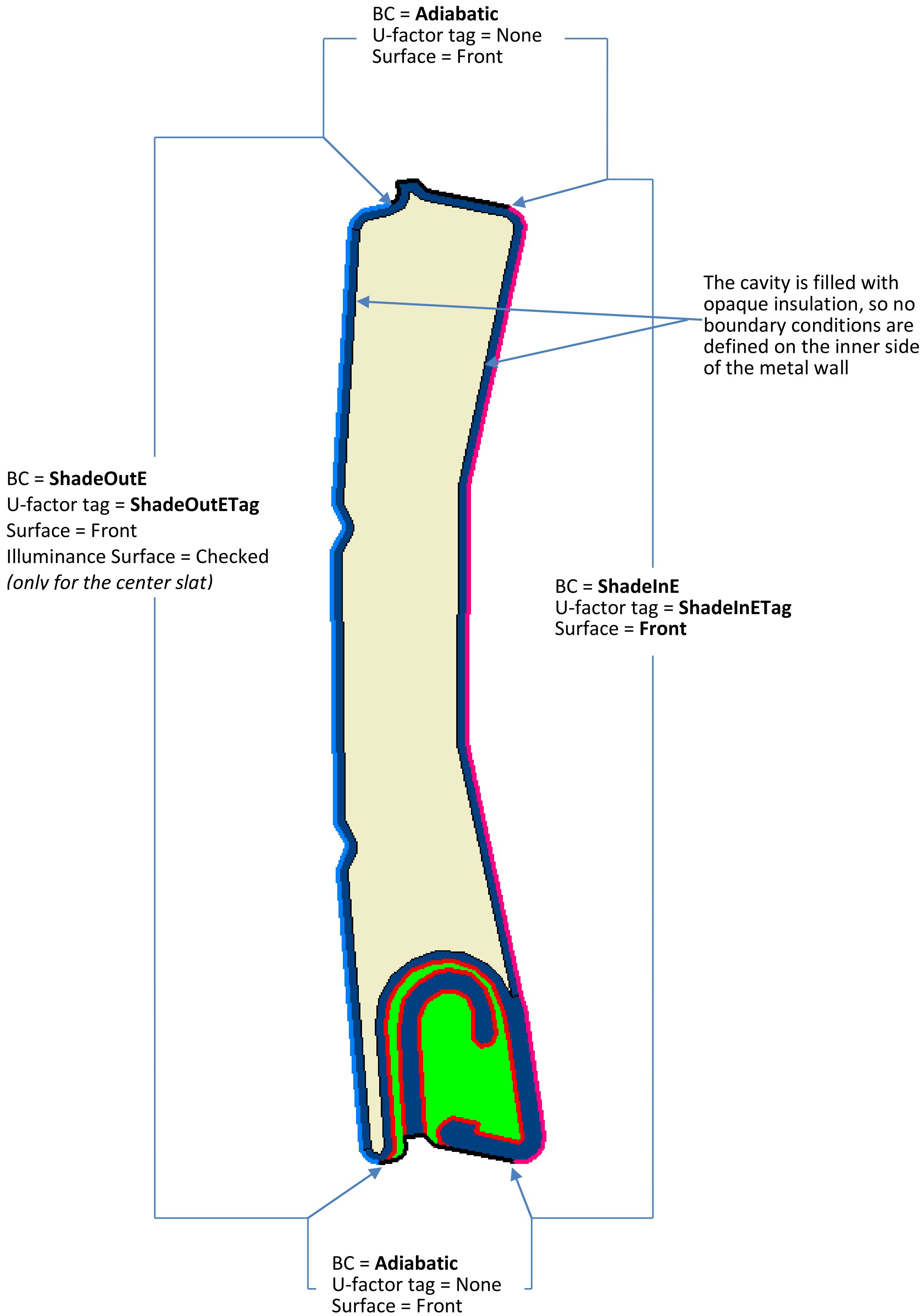


Figure 19-118.The Boundary Conditions for the insulated roller shutter case.

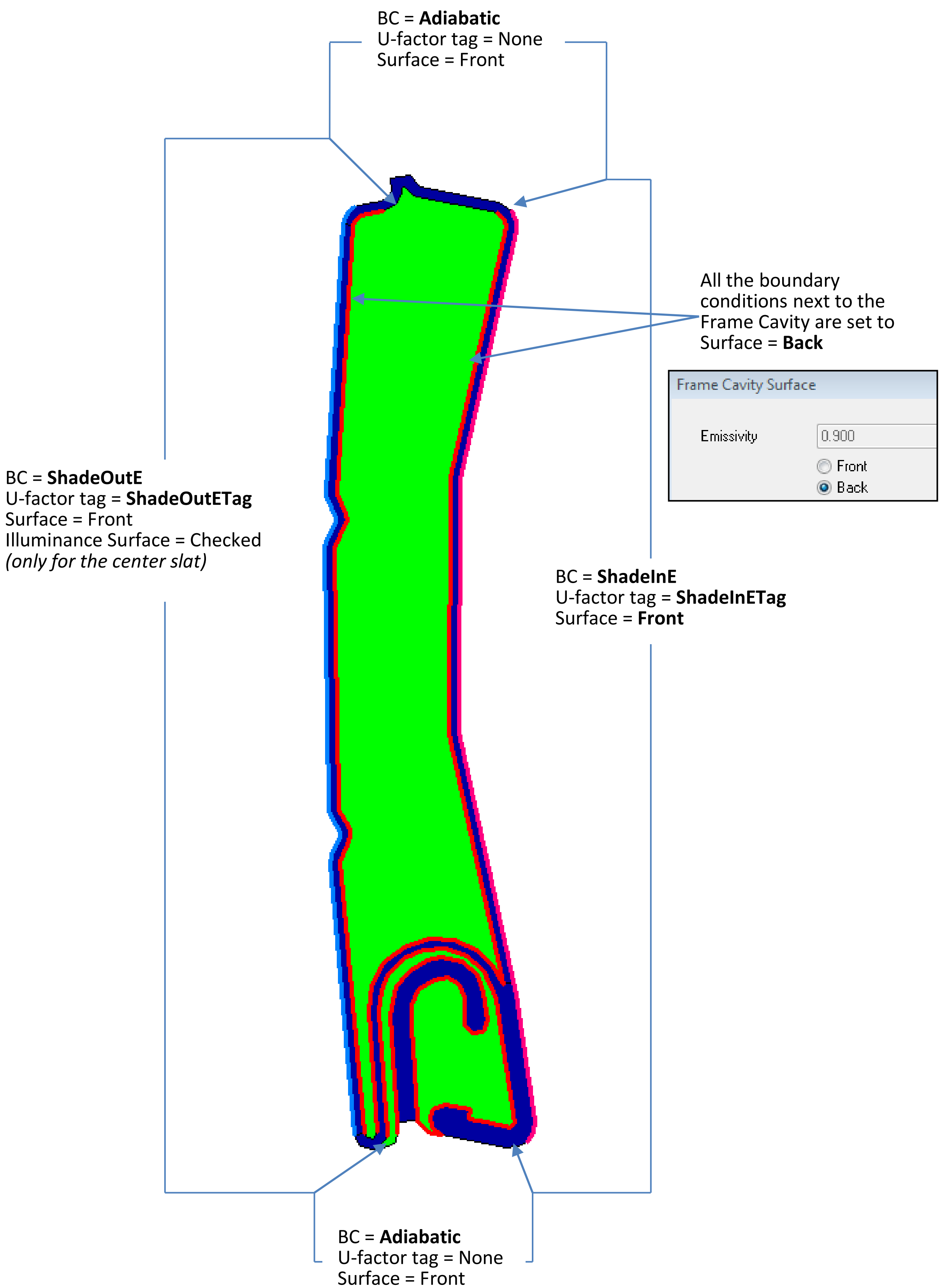


Figure 19-119.The Boundary Conditions for the uninsulated roller shutter case.

The boundary conditions should be set as follows:

There are two predefined boundary conditions and U-factor tags for the interior and exterior boundary conditions of the cell geometry

- Exterior surfaces
    - Boundary Condition: **ShadeOutE**
    - U-factor surface tag: **ShadeOutETag**

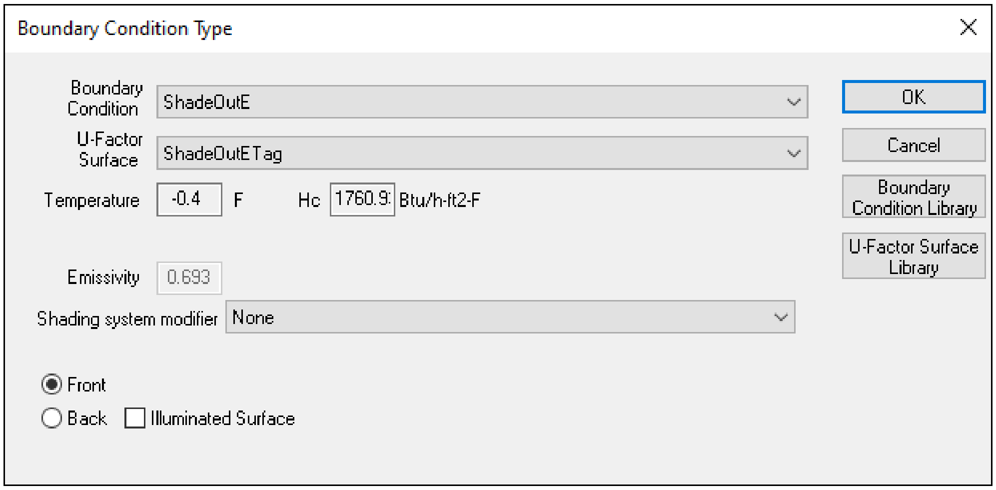


Figure 19-120. ShadeOutE Boundary Condition

- Interior surfaces
    - Boundary Condition: **ShadeInE**
    - U-factor surface tag: **ShadeInETag**

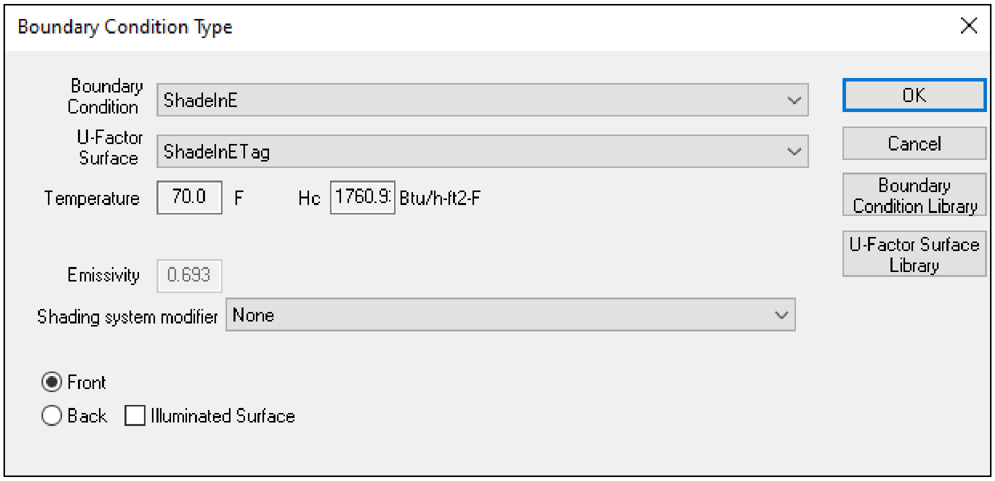


Figure 19-121. ShadeInE Boundary Condition

19.7.6. Calculate the Model for Error Checking

Calculate the model before progressing to ensure there are no errors. If changes are required, ensure all polygon and boundary conditions are re-linked to shade materials

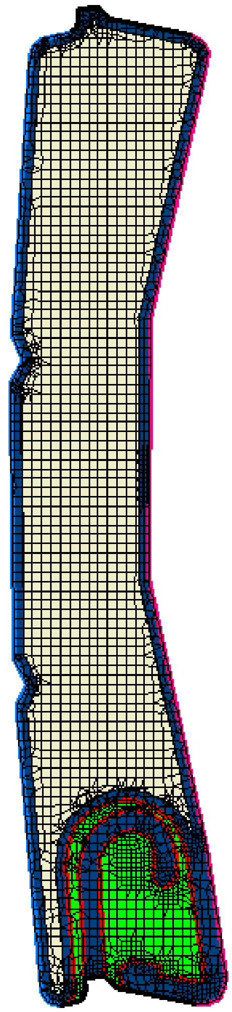


Figure 19-122. Calculate the model to make sure there are no meshing errors

19.7.7. Create an array of cells

Depending on the shading system, multiple shade component segments are generally defined for the complete THERM model. In the case of an opaque shading layer, it is not necessary to generate as many repeating segments as for a transmitting material (which will have light scattered in much more complex geometry).

For this roller shutter example, only three repeating segments are modeled, as shown in the figure below.

Create an array of component with 1 component above and 1 component below the center component.

See the THERM User Manual for detailed instructions about how to copy and paste polygons within the same file or between different files.

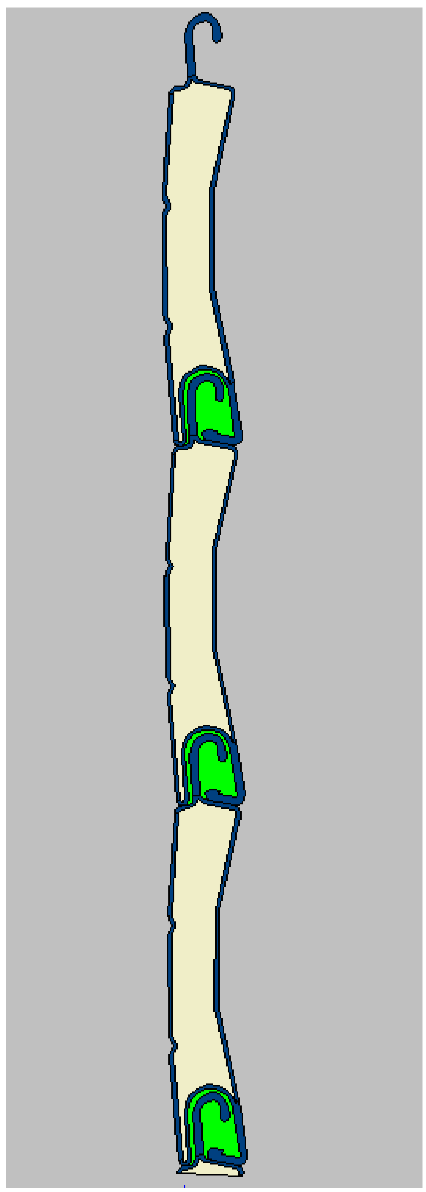


Figure 19-123. Repeat until there are 5 cells above and 5 cells below the center cell.
The gray background indicates that "Radiance Mode" is checked.

19.7.8. Generate the boundary conditions for the complete array of segments

Leave boundary conditions visible to ensure the boundary condition settings are copied along with the polygons.

The exterior facing surface of the middle component should have the Illuminated Surface checked in the Boundary condition definition

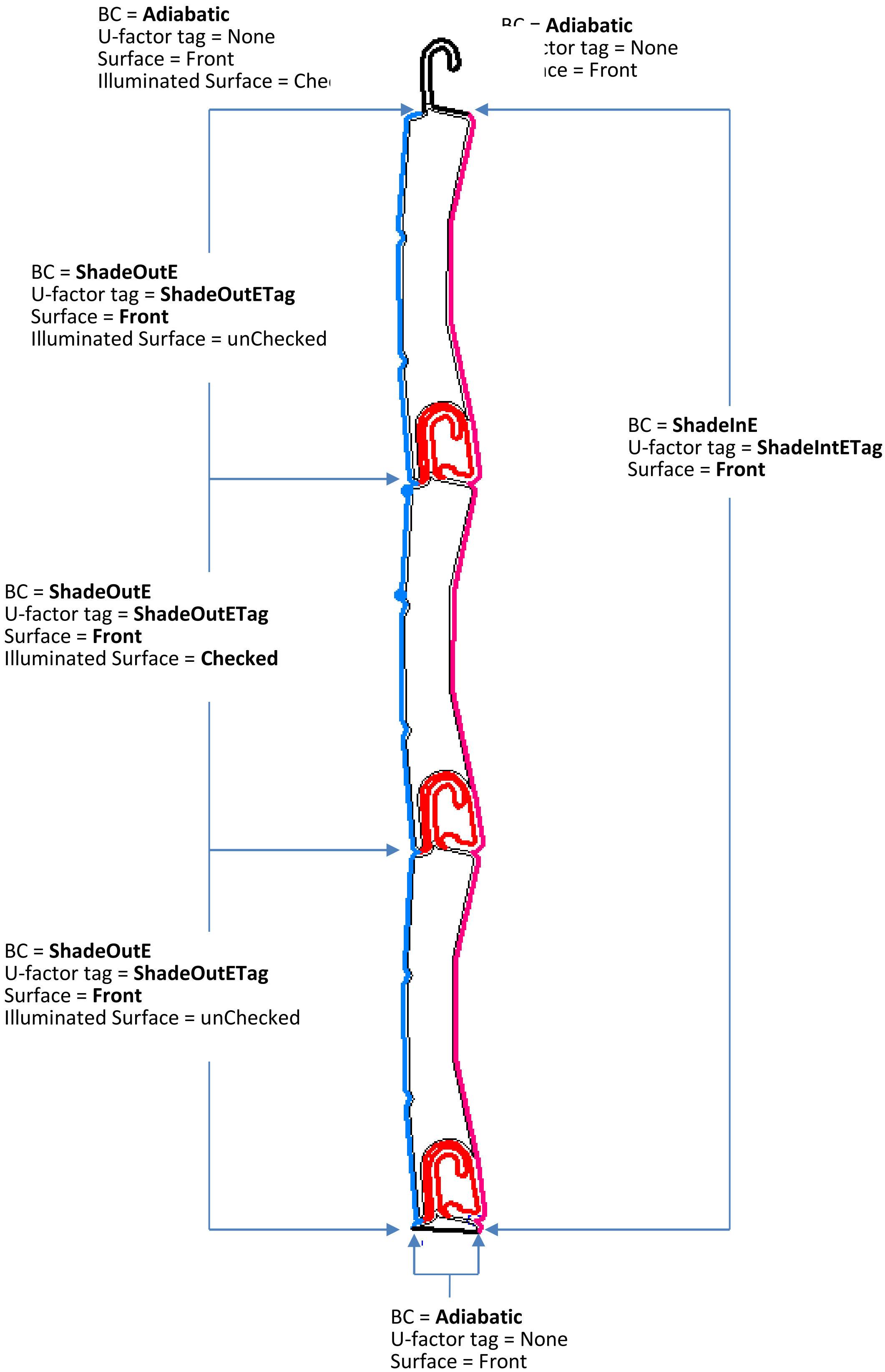


Figure 19-124. Check the "Illumination Source" for the left most (outer) walls of the center cell

19.7.9. WINDOW: Create the Shading Layer

In WINDOW, go to the Shading Layer Library, and create a new record

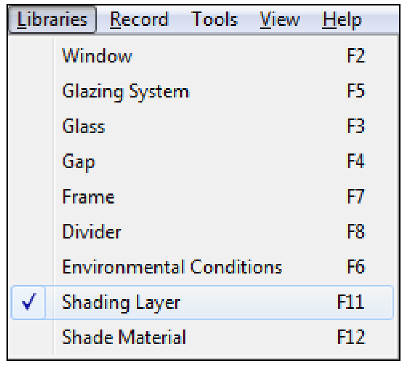


Figure 19-125. Select the Shading Layer Library

- Set Type to Therm File (*.thmx)
- BSDF File: Browse to thmx file created in Term

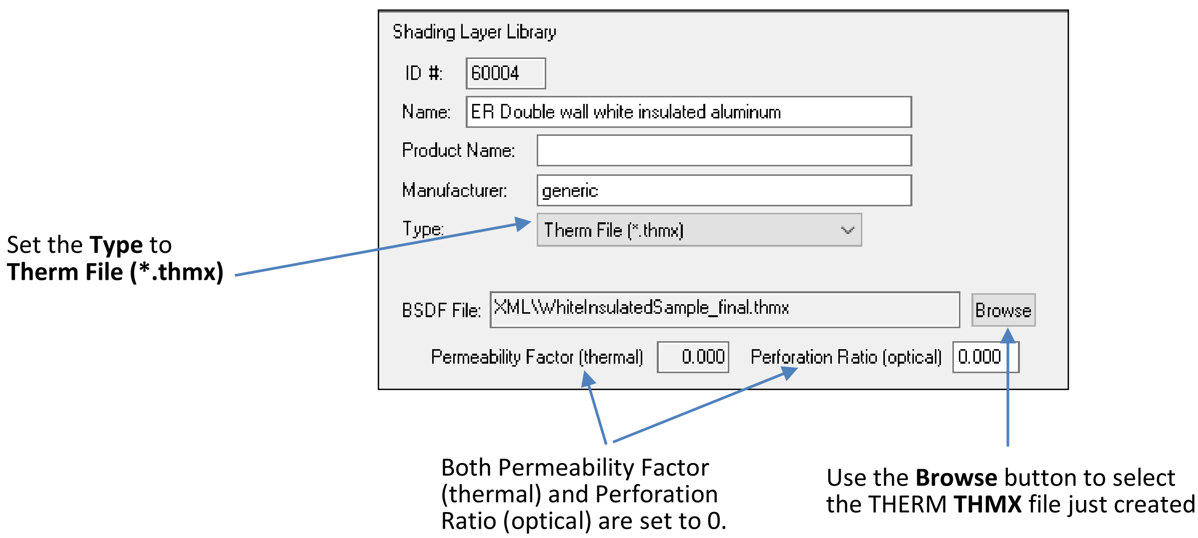


Figure 19-126. Create a new Shading Layer Library record and set the BSDF file to the THERM thmx file just created.

Set the **Permeability Factor (thermal):**

Because this is an opaque material with well sealed joints, the Permeability factor = 0.

This is the airflow permeability for the shading layer system. For single layer systems, such as pleated shades, the permeability factor (thermal) of the single material is entered. For multiple layer systems, the shade material with the lowest permeability factor (thermal) in the airflow critical path is used. The critical path for several systems is illustrated in the figure below. This must be set befor clicking the Calc button, which runs Radiance.

Set the Perforation Ratio (optical):

Because this is an opaque material with well sealed joints, the Optical Openness = 0.

Optical properties of the shading layer are calculated with the Calculate button by Radiance. This calculation is based on only the material properties and geometry in the Therm file (*.thmx). Large scale perforations in a shade layer, which are not accounted for in the material properties or therm file (*.thmx) can accounted for by determining the equivillent open area of the perforations and entering the ratio of open area to total layer area as the Perforation Ratio (optical). Perforations must be in a regular repeating pattern and distributed over the entire layer area. The primary example for a shading layer of the Therm file (*.thmx) type with Perforation Ratio (optical) is a roller shutter with perforated slats. The Perforation Ratio (optical) is calculated using the methods described in the Perforated Screens section. This must be set befor clicking the Calc button, which runs Radiance.

- Click the Calc button to calculate the gen_BSDF file. NOTE: This calculation will take around 70 minutes.

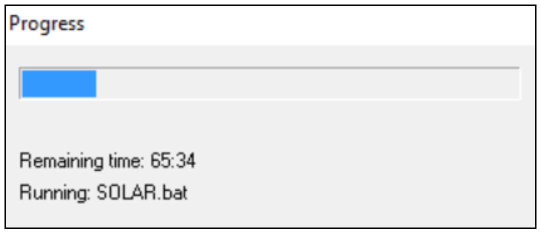


Figure 19-127. Calculating the BSDF file can take over an hour, depending on the computer.

The properties of the material from the WINDOW database are stored in the THMX file, meaning that once the file is saved, it is independent of any subsequent changes to the WINDOW database used to produce it. Therefore, if the properties of materials used in the WINDOW database change, the THMX file must also be regenerated in order to keep the properties up-to-date.


```
<Material Name="CS03:CS03_glueline.txt" Type="5" Conductivity="0.120000" Tir="0.000224" EmissivityFront="0.777410" EmissivityBack="0.781640" RGBColor="0x4951EB">
    <Property Side="Front" Range="Visible" Specularity="Direct" T="0.000000" R="0.000000"/>
    <Property Side="Front" Range="Visible" Specularity="Diffuse" T="0.269345" R="0.711613"/>
    <Property Side="Front" Range="Solar" Specularity="Direct" T="0.000000" R="0.000000"/>
    <Property Side="Front" Range="Solar" Specularity="Diffuse" T="0.267214" R="0.686956"/>
    <Property Side="Back" Range="Visible" Specularity="Direct" T="0.000000" R="0.000000"/>
    <Property Side="Back" Range="Visible" Specularity="Diffuse" T="0.269345" R="0.689204"/>
    <Property Side="Back" Range="Solar" Specularity="Direct" T="0.000000" R="0.000000"/>
    <Property Side="Back" Range="Solar" Specularity="Diffuse" T="0.267214" R="0.665194"/>
</Material>
```


Figure 19-128. The THMX file (a text file) is independent of the WINDOW database where the THERM materials were imported from

This shading layer can now be used when defining a glazing system.

19.8. Perforated Screens

Perforated screens are shading materials that have a uniform geometry. Perforations must be in a regular repeating pattern of a single shape (circular, square, or rectangular). Non-regular patterns can be approximated by determining the equivalent area.

Permeability Factor is calculated by WINDOW based on the geometry of defined perforations. To utilize this model, the referenced shade material properties must be the bulk material without perforations and should represent a perfectly Lambertian diffusing material.

19.8.1. Shading Layer Library

The Shading Layer Library has an Type called "Perforated screen". When that type is selected, the program displays the input values for defining the type and geometry.

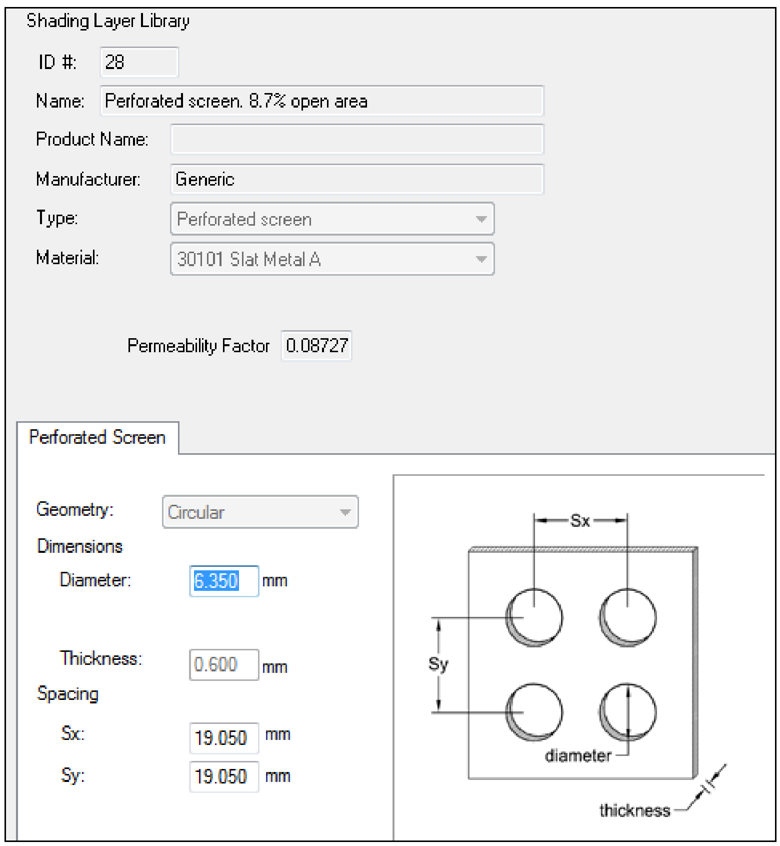


Figure 19-129. Circular perforated screen model. Diameter, and distance between perforations is defined

In WINDOW, go to the Shading Layer Library, and create a new record.

Type	Set to Perforated screen
Material	Select the appropriate record in the Shade Material Library
Permeability Factor	This value is calculated automatically by WINDOW based on the geometry of the defined perforations. To utilize this model, the referenced Shade Material properties must be the bulk material without perforations and should represent a perfectly Lambertian diffusing material.

Geometry Select from the following options

- Circular
  - Define diameter of typical perforation open area
  - Define spacing between perforations in the x (Sx) and y (Sy) dimensions
  - Eliptical shapes may be approximated as circular shapes using equvillent area where the diameter, D, is related to the semi-major and semi-minor axes of an ellipse as follows:

D = 2 sqrt(AB)

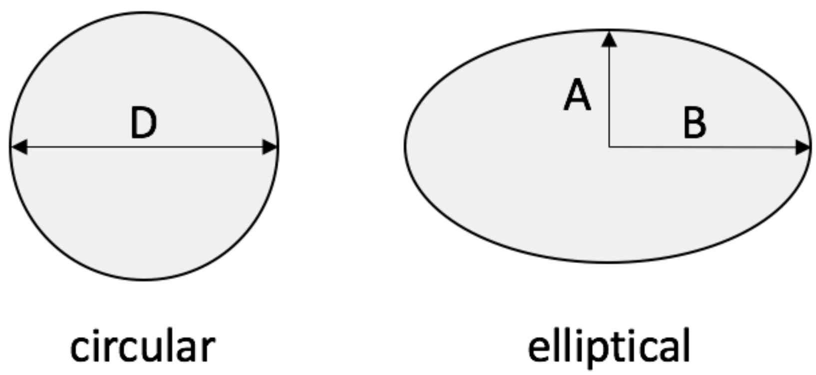


Figure 19-130. Elliptical perforations can be related to circular perforations by equivillent area

- Square
  - Define length of the typical perforation open area
  - Define spacing between perforations in the x (Sx) and y (Sy) dimensions

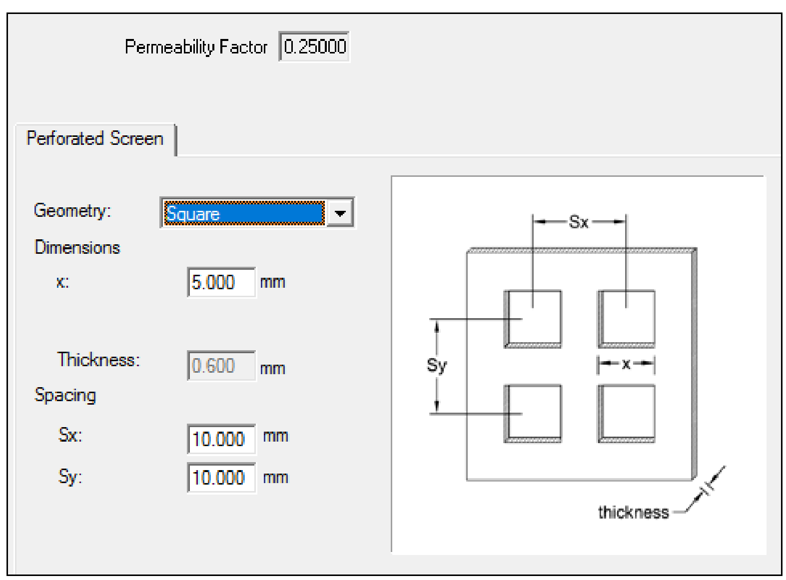


Figure 19-131. Square perforated screen model. Side lengths and distance between perforations is defined

- Rectangular
    - Define the Width (x) and Height (y) of the typical perforation open area
    - Define spacing between perforations in the x (Sx) and y (Sy) dimensions
    - Non-standard shapes may be approximated as rectangular shape using equvillent area where the smallest dimension of the shape is equal to the smallest dimension of the rectangle

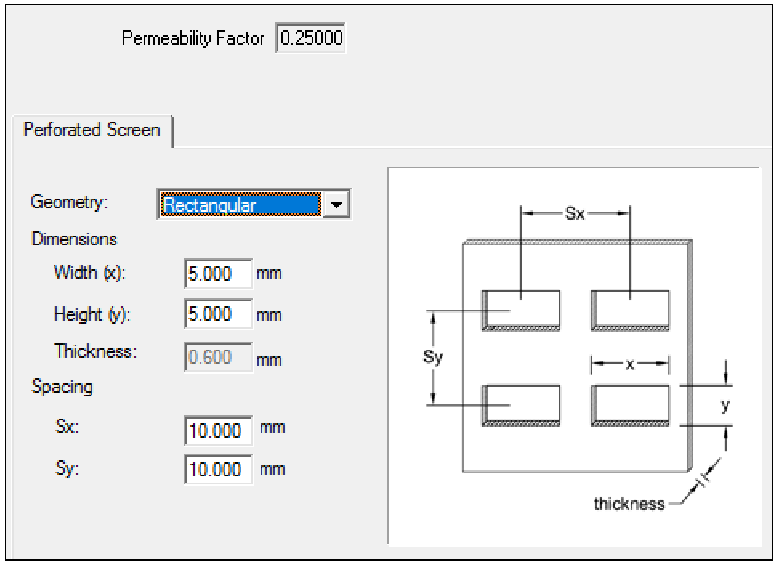


Figure 19-132. Rectangular perforated screen model. Width (x) and Height (y) side lengths, and distance between perforations (Sx and Sy) is defined

19.9. Homogeneous Diffusing shade

The homogeneous diffusing shade option in shading layer library utilizes shade material properties of the bulk material without perforations and should represent a perfectly Lambertian diffusing material.

19.9.1. Create the Shading Layer in WINDOW

In WINDOW, go to the Shading Layer Library, and create a new record.

- Set Type to Homogeneous diffusing shade
- Set Material to record in the Shading Material database
- Set the Permeability Factor.

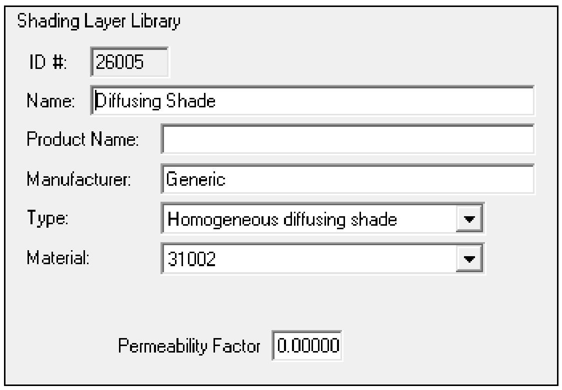


Figure 19-133. Homogeneous diffusing shade type from the Shading Layer Library. Material is defined in the Shading materil library. Permeability factor is determined through measurements

19.10. Awnings

Awnings are defined by the geometry of the awning (see the figure below) as well as the material of the awning.

The material for the awning is selected from the Shading Layer Library.

The awning geometry is defined relative to a window, so that an awning defined in the Awning Library can be applied to any window in the Window Library.

19.10.1. Awning Library

The Awning Library

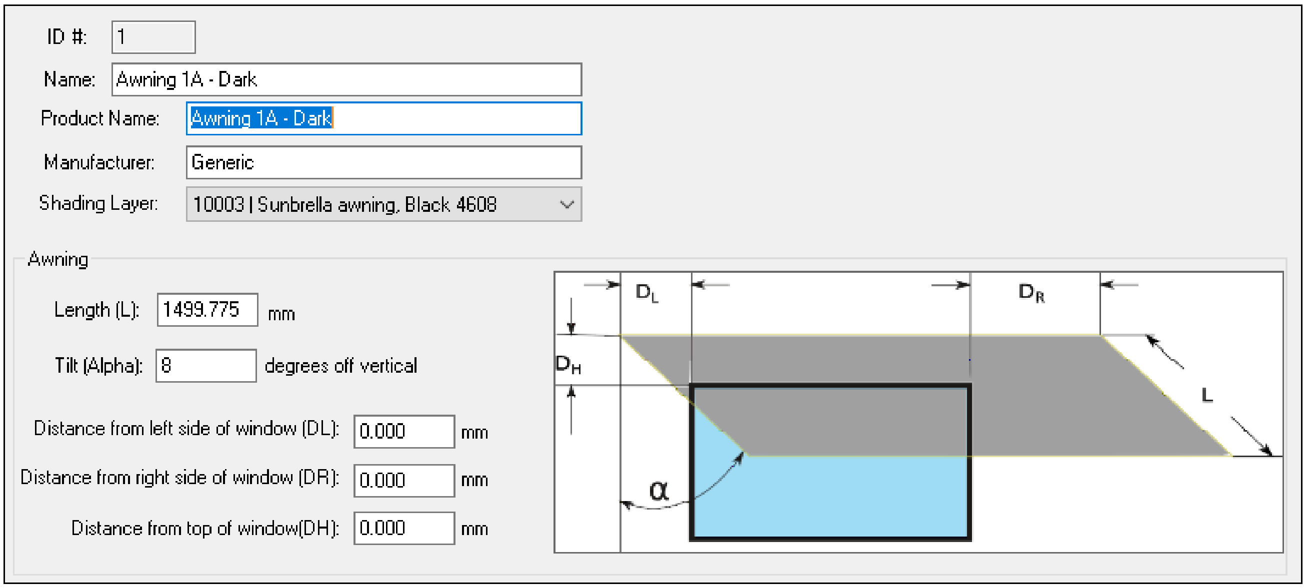


Figure 19-134. Awning Library

In WINDOW, go to the Awning Library, and create a new record.

ID	The unique ID associated with this record. Protected.
Name	The name of the Awning being defined.
Product Name	The product name of the Awning being defined.
Manufacturer	The name of the awning manufacturer.
Shading Layer	The name of the Shading Layer used to define the material of the awning. The pulldown list shows all the applicable Shading Layers that can be used to define awning materials. The records from the Shading Layer library that can be used for awnings are those that are defined as “Shade with XML data” in the Shading Layer detail view, and “BSDF” in the Shading Layer List view.

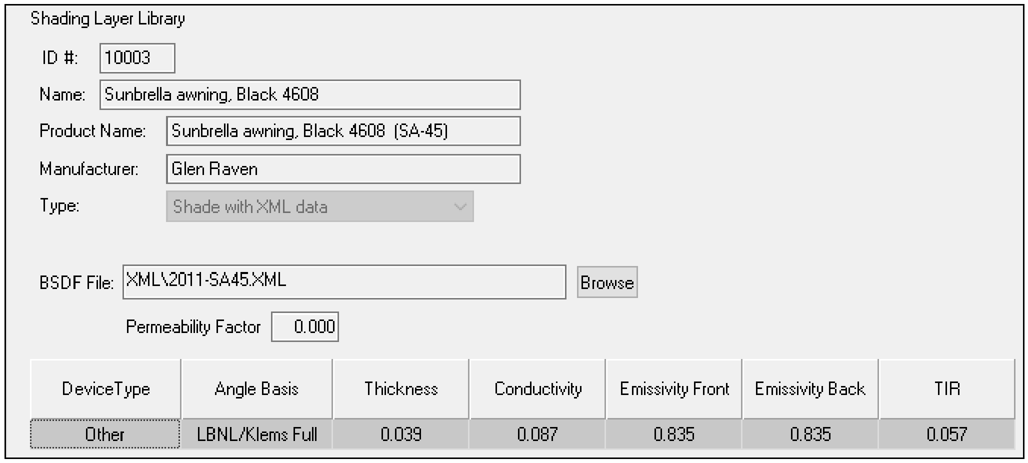


Figure 19-135. Shading Layer records defined as Type = Shade with XML data are those that can be used to define awnings.

AWNING

Length (L) The length of the awning, measured from the wall attachment to the end of the awning. **Units:** mm (SI); inches (IP).

Tilt (Alpha) The tilt of the awning, measured from the vertical wall surface. **Units:** degrees off vertical.

Distance from left side of window (DL) Distance from the left hand side of the window to the left hand edge of the awning. **Units:** mm (SI); inches (IP).

Distance from right side of window (DR) Distance from the right hand side of the window to the right hand edge of the awning. **Units:** mm (SI); inches (IP).

Distance from top of window (DH) Distance from the top of the window to the point where the awning is attached to the wall. **Units:** mm (SI); inches (IP).

19.10.2. Applying Awnings to a Window

Unlike other shading systems that are applied to Glazing Systems, which are then used in a window, awnings are applied directly to Windows.

An option to specify an awning for any window has been added to the definition of a window record in the Window Library.

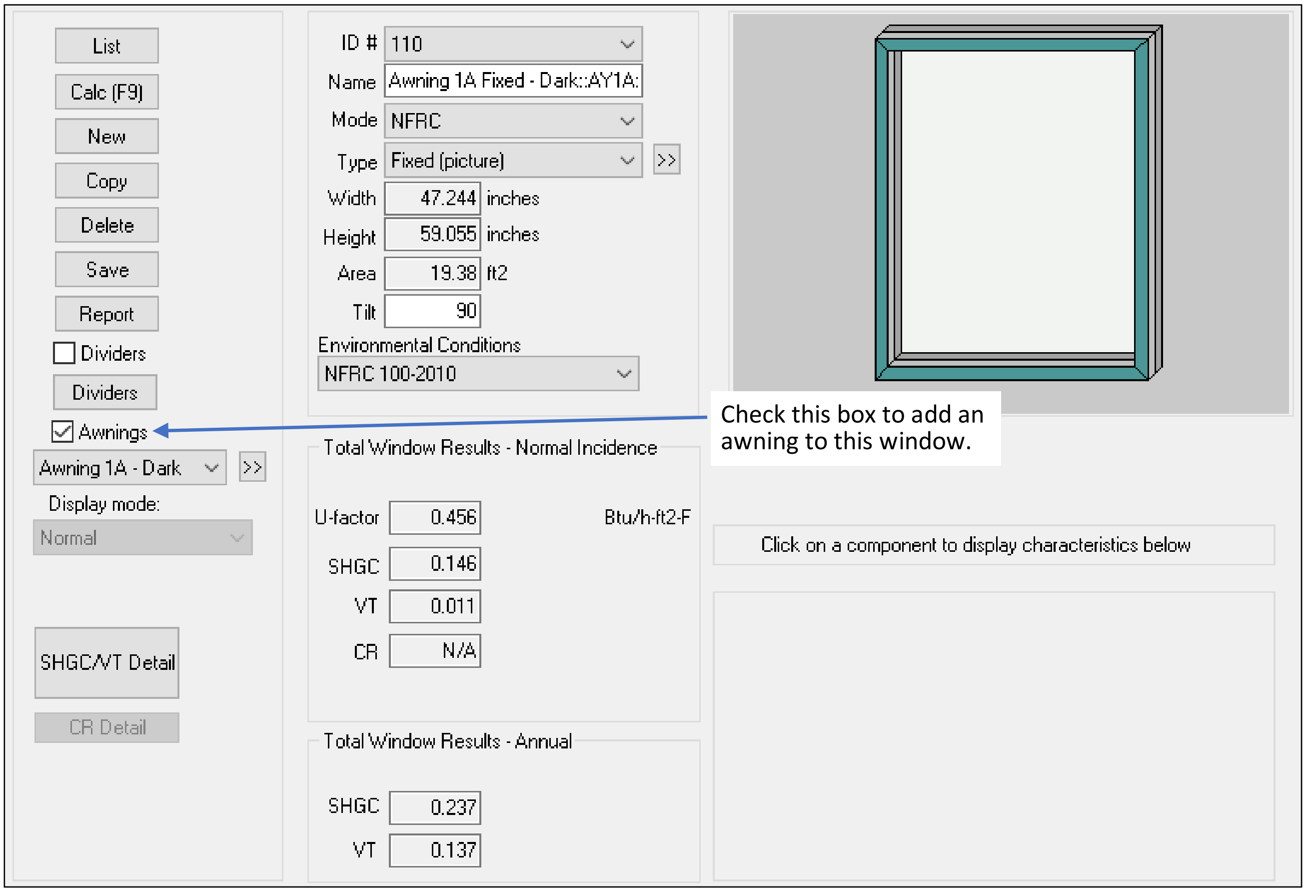


Figure 19-136. Awnings are applied directly to Window records.

Checking the "Awnings" box will allow records from the Awning Library to be selected either from the pulldown list or by clicking the double arrow to the right of the pulldown list to open a dialog box showing the list of records.

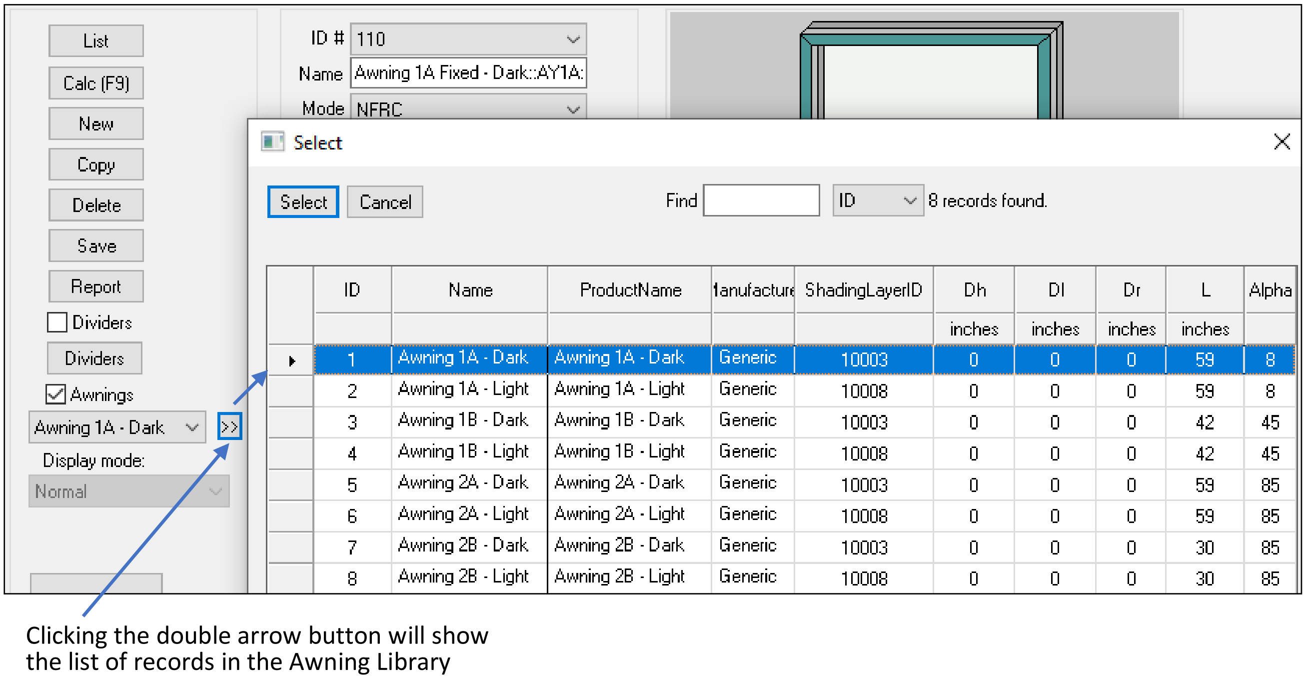


Figure 19-137. Access the list of awnings from the Awnings Library by clicking on the double arrow button

When you press the Calc button to calculate the window with the awning, a "DOS" screen will appear, which is running Radiance to calculate the optical properties of the window with the awning. When Radiance has completed the calculation (which can take a few seconds up to many minutes) the DOS screen will close automatically.

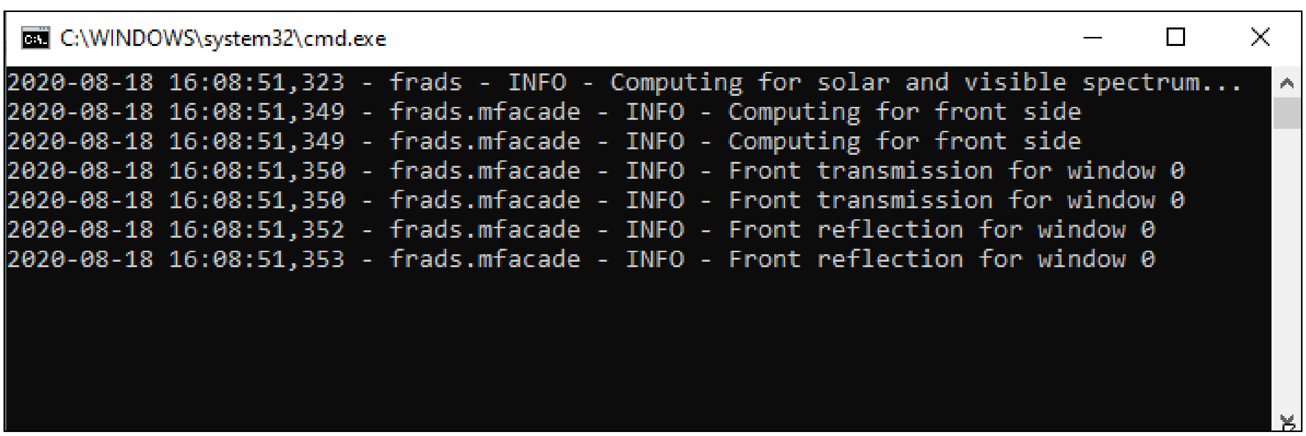


Figure 19-138. When calculating the window performance with an awning, a DOS screen will appear during the Radiance calculation of the optical properties of the system.

Results

When the program has finished the calculation, there will be two sets of results, one calculated at normal incidence, and the other calculated as "annual results". The values calculated at normal incidence will generally not be relevant for awnings, so the Annual results will be more useful. See the AERC technical documentation for a description of Annual results.

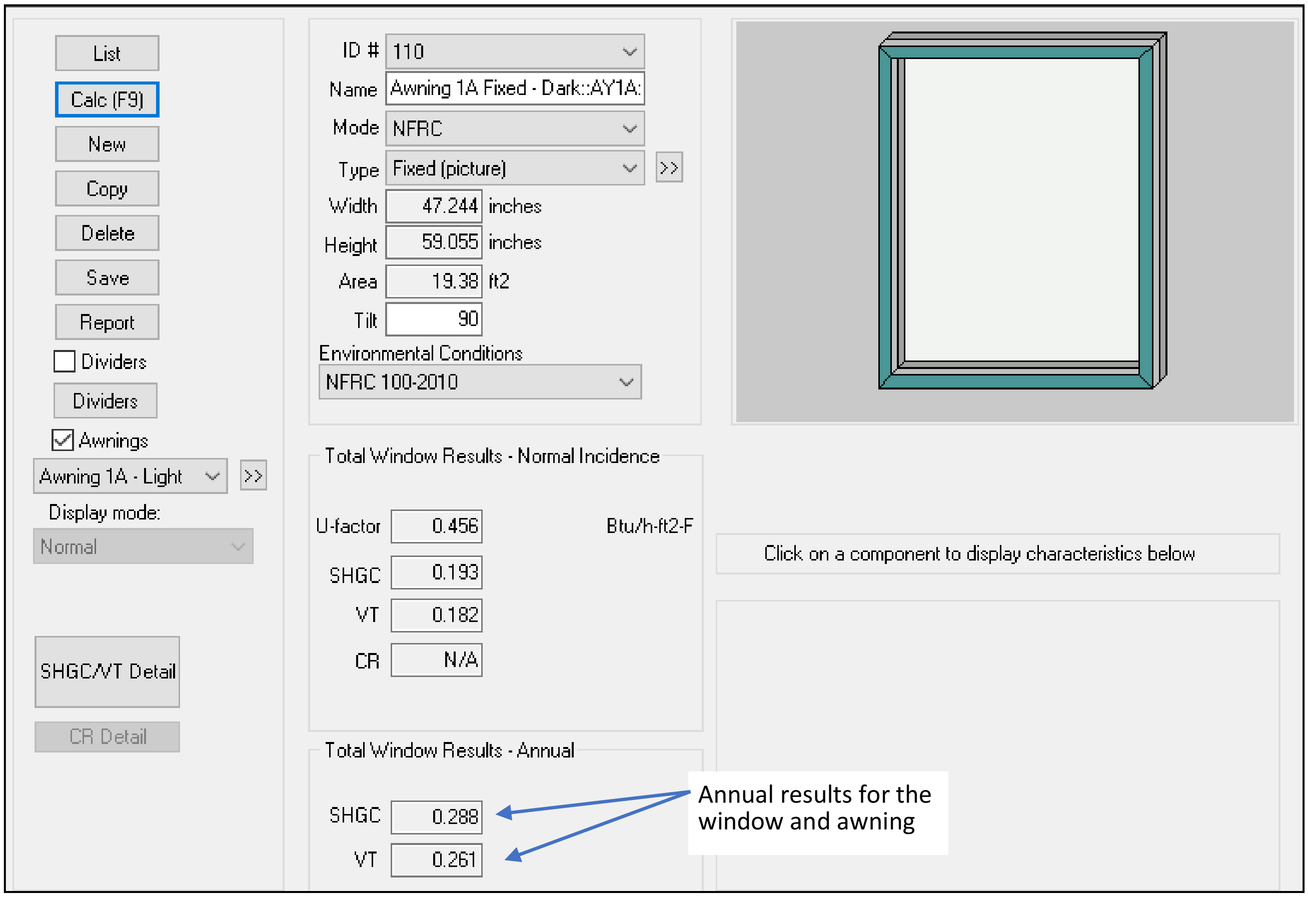


Figure 19-139. For awnings, the "Annual" results will be more relevant.

19. Shading Systems 1